



National Oceanographic Partnership Program

NAVY*NOAA*NSF*NASA*DoE*EPA*USCG*USGS*DARPA*MMS*OSTP*OMB*DoS*USACE

**Report to the U.S. Congress
on the
National Oceanographic Partnership Program
(Fiscal Year 2001)
on behalf of the
National Ocean Research Leadership Council
(NORLC)**

March 1, 2001

Table of Contents

Executive Summary

I. Introduction

II. NOPP Investment Strategy

III. Fiscal Year 2000 Activities

IV. Fiscal Year 2001 Activities

V. Fiscal Year 2002 Plans

VI. Interagency Coordination Activities

VII. Appendices

**1. Fiscal Year 2000 and 2001 NOPP funded University-National Oceanographic
Laboratory System (UNOLS) Academic Ship Survey Schedules**

2. National Ocean Research Leadership Council (NORLC) Meeting Minutes

3. Ocean Research Advisory Panel (ORAP) Meeting Minutes

4. National Ocean Sciences Bowl (NOSB) Terms of Reference

5. Federal Oceanographic Facilities Committee (FOFC) Charter

**6. Fiscal Year 2001 National Oceanographic Partnership Program Broad Agency
Announcement**

7. NOAA Argo Float Solicitation

8. Navy Small Business Innovative Research (SBIR) Solicitation

9. Ocean.US Memorandum of Agreement

**10. Ocean Research Advisory Panel Report “Strategic Vision for Achieving Sustainable
Marine Resources Within the US EEZ”**

11. Ocean Research Advisory Panel Members

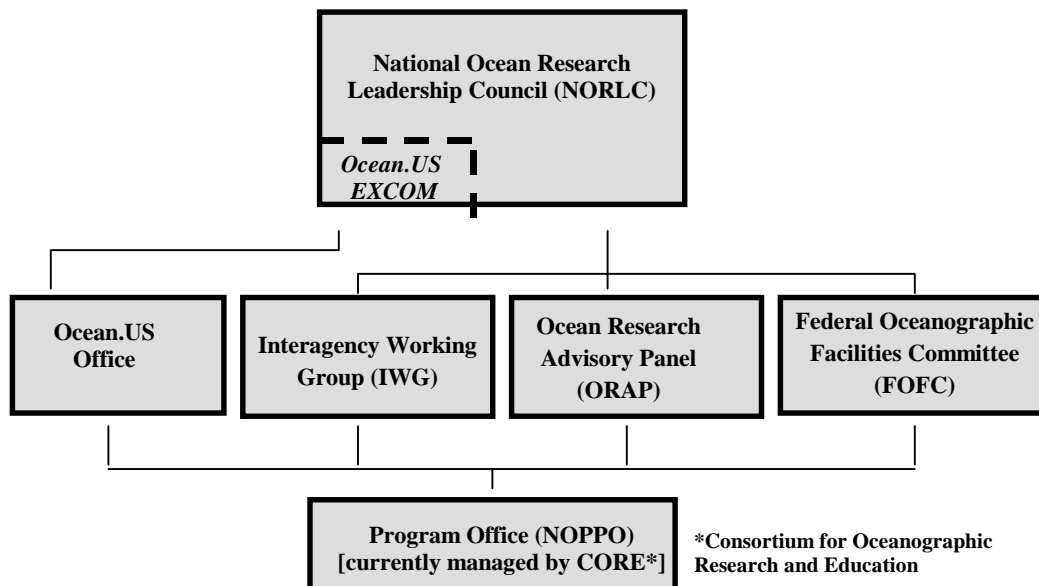
12. FY 1998 – 2000 National Oceanographic Partnership Program Project Reports

EXECUTIVE SUMMARY

Remarkable progress was achieved in all aspects of the Program during the past year.

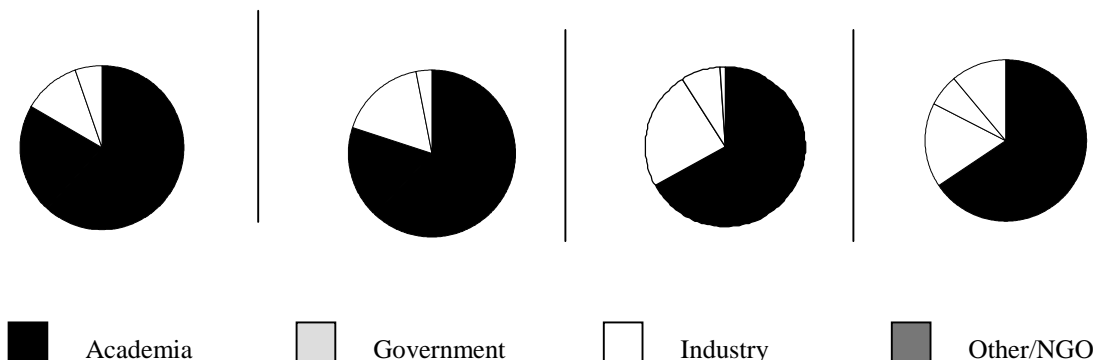
Background:

- FY 1997 Defense Authorization (P.L. 104-201) directed the Secretary of the Navy to establish the National Oceanographic Partnership Program (NOPP).
- The NOPP organization is shown below.



- The NOPP funding distribution to date:

1997	1998	1999	2000
55 proposals	72 proposals	70 proposals	47 proposals
11 projects funded	12 projects funded	13 projects funded	18 projects funded
\$12M research	\$16M research	\$14M research	\$15M research
Partner 'costshare' = \$27M	Partner 'costshare' = \$15M	Partner 'costshare' = \$15M	Partner 'costshare' = \$15M



- An additional \$25.5M has been invested via the University-National Oceanographic Laboratory System (UNOLS) for military ocean surveys aboard academic research vessels.

NOPP Investment Strategy: The NOPP investment portfolio is based on the societal needs identified by Dr. Worth Nowlin of Texas A&M University and Dr. Tom Malone of the University of Maryland in the report “Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System.” The five NOPP investment areas listed below represent an intersection between emerging national ocean research needs and agency priorities:

- Operational/Routine Observations (including pilots, test beds, etc.)
- Research “Observatories” (long-term experiments and data series, etc.)
- Observational Technique Development (sensors and platforms)
- “Commons” for Ocean Information (“hubs” and “nodes”, etc.)
- Outreach/Education.

Highlights from the past year:

- A first time funding collaboration with a non-governmental organization occurred in FY 2000. NOPP and the Alfred P. Sloan Foundation jointly funded eight Ocean Biogeographical Information System projects.
- On May 25, 2000 the House Resources Subcommittee on Fisheries, Conservation, Wildlife, and Oceans and the Armed Services Subcommittee on Military Research and Development held a joint hearing to examine the December 1999 Ocean Research Advisory Panel Report, *An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan*.
- Three new members were invited to join the ORAP in FY 2001: Dr. Marcia McNutt, President and Chief Executive Officer of the Monterey Bay Aquarium Research Institute; Mr. Lawrence Dickerson, President and Chief Operating Officer of Diamond Offshore Drilling, Inc.; and Dr. Denise Stephenson-Hawk, Chair of the Stephenson Group, a consulting firm in Atlanta, GA.
- The Department of State and the U.S. Army Corps of Engineers accepted the National Ocean Research Leadership Council’s invitation to participate in Council meetings.
- In collaboration with the Consortium for Oceanographic Research and Education, the Partnership Program will sponsor future National Ocean Sciences Bowl events. This Ocean Sciences Bowl is a nationwide academic competition for high school students.
- At the direction of the National Ocean Research Leadership Council (NORLC), the Ocean.US Office of NOPP was chartered on October 25, 2000. As described in the Memorandum of Agreement to establish the Ocean.US Office, an Executive Committee of the NORLC will provide guidance to the Office Director and his staff. The Ocean.US office will serve as the central focal point in the development of a national integrated, sustained ocean observing system.

- The Federal Oceanographic Facilities Committee (FOFC), restructured from the Federal Oceanographic Fleet Coordination Council, was established as a new NOPP committee under the NORLC. The inaugural meeting of this interagency committee was held 29 November 2000.
- The December 18, 2000 FY 2001 Partnership Program Research Solicitation consists of three parts:
 1. A Broad Agency Announcement (BAA) is soliciting research in observation demonstration/pilot projects, technique development, and data management;
 2. The Department of Commerce (NOAA), on behalf of NOPP, issued a solicitation for preliminary proposals (Letters of Intent) and subsequently full proposals to implement the next phase of the U.S. contribution to the global Argo array of profiling floats; and
 3. The Navy issued a Small Business Innovative Research (SBIR) solicitation for innovative communication methods from remote platforms.
- At the request of the NORLC, the Ocean Research Advisory Panel (ORAP) prepared the report, “Strategic Vision for Achieving Sustainable Marine Resources within the U.S. EEZ.” This report was delivered to the NORLC and the President’s Science Advisor in January 2001.
- Associated Trends, an organization of association executives, selected the ‘NOPP Special Issue’ of Oceanography Magazine, the Oceanography Society’s periodical, for one of two Honorable Mentions from several hundred competitors in the ‘Professional Journal’ category. This issue was widely distributed nationally and internationally.

I. Introduction

The National Oceanographic Partnership Program (NOPP) was established in Fiscal Year 1997 through Public Law 104-201. Supplemental legislation for appointments to the NOPP oversight body, the National Ocean Research Leadership Council (NORLC), and the Ocean Research Advisory Panel (ORAP) is contained in Public Law 105-85, the FY 1998 Defense Authorization Act.

The Secretary of the Navy is charged in Subtitle E of title II, Division A, Public Law 104-201 to establish a National Oceanographic Partnership Program to:

- 1) promote the national goals of assuring national security, advancing economic development, protecting quality of life, and strengthening science education and communication through improved knowledge of the ocean; and
- 2) coordinate and strengthen oceanographic efforts in support of those goals by:
 - a) identifying and carrying out partnerships among Federal agencies, academia, industry, and other members of the oceanographic scientific community in the areas of data, resources, education, and communication, and
 - b) reporting annually to Congress on the Program.

This report of the Fiscal Year 2001 Partnership Program meets that statutory requirement.

II. NOPP INVESTMENT STRATEGY

The seven societal needs identified by Dr. Worth Nowlin of Texas A&M University and Dr. Tom Malone of the University of Maryland in the report “Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System” form the basis of the NOPP Investment Strategy. These needs are listed below:

- Detecting and forecasting oceanic components of climate variability;
- Facilitating safe and efficient marine operations;
- Ensuring national security;
- Managing living resources for sustainable use;
- Preserving healthy and restoring degraded marine ecosystems;
- Mitigating natural hazards; and
- Ensuring public health.

The five elements of the NOPP Investment Strategy (described below) support emerging U.S. ocean research needs.

A. Operational/Routine Observations

This NOPP investment area is for operational observation efforts, including demonstrations and pilot projects that may lead to new operational capabilities. Sustained, long-term, routine observations are used to generate products responding to user-defined needs or requirements.

B. Research “Observatories”

This NOPP investment category includes observational efforts such as long time-series research (exploring in four dimensions) which will yield important fundamental discoveries about how the ocean and its ecosystems interact over time, and will lead to optimization of operational observing systems. Knowledge of the mechanisms of long-term climate change and its interactions with fish stock fluctuations, for instance, are essential to design effective systems to monitor and predict fish stock fluctuations and permit operational catch quotas annually. NOPP has funded the development of integrated coastal observatories (e.g. LEO-15 off New Jersey), and the conceptual design of sea floor observatory networks further offshore (e.g. NEPTUNE), which could potentially monitor the biological productivity and fish stocks over a large area of the continental shelf. Additional existing open ocean time-series, such as the Hawaiian Ocean Time-series (HOT) and Bermuda Area Time Series (BATS), could also eventually be coordinated and integrated into Ocean.US data streams.

C. Observational Technique Development

NOPP is interested in the development and/or demonstration of coastal and open ocean observational instrumentation, platforms and techniques to establish new means for continuous, high-resolution measurements of oceanic processes. A principal challenge in this area is to develop rapid analytical techniques and “smart” sampling tools based on real-time measurements.

NOPP is particularly interested in:

- 1) autonomous and/or long-term and/or distributed approaches that provide a new observational capability for the ocean community and
- 2) Innovative sensors and measurement techniques to obtain oceanographic variables (e.g., chemical, optical, or biological) in 3-D space and time to augment physical variables.

D. “Commons” for Ocean Information

The Partnership Program has initiated several efforts toward a community-wide, linked ‘system’ of resources, collaborations, and elements for ocean observing and predicting activities. The genesis for this initiative was a series of workshops in 1997 (Nowlin) and 1998 (Powell) illuminating the need for an Ocean Research Synthesis and Modeling Program (ORSMP) which garnered further impetus and definition with the publication of the NOPP report “Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System” in April 1999. Background on the workshops can be found in Nowlin (1997) and Powell (1998), available through the NOPP web site.

To address these needs, new infrastructure and partnerships are required that span the ocean community. A concept has been developed to address these needs by evolving in a phased manner and involves a central “hub facility” supporting a number of “nodes.” The hub (or hubs) will provide computational and data assimilation capabilities, high-level analyses, technical assistance, code and analysis software, benchmark solutions, documentation, and other services. Nodes are envisioned as small to large teams (5-15 researchers) collaborating on model/data synthesis projects requiring regional- to global-scale computational capability.

E. Outreach/Education

In an era of declining science literacy, the oceans readily provide an exciting vehicle to stimulate learning and promote math and science education. NOPP seeks to invest in projects directly addressing public education.

III. FISCAL YEAR 2000 ACTIVITIES

The FY 2000 Program

The FY 2000 National Oceanographic Partnership Program invested \$15M towards an Integrated Ocean Observing and Prediction System; the Ocean Biogeographical Information System; Regional and Special Ocean Observation Initiatives; and renewal of Education and Outreach projects originally funded in the FY 1997 Program.

Forty-seven research proposals responding to the September 16, 1999 solicitation were evaluated using merit based competitive procedures. Project summaries included in the final Appendix describe the 12 new and 6 renewal projects funded, as well as the projects funded in the FY 1998 and FY 1999 Programs.

The investment in the Ocean Biogeographical Information System (OBIS) represents a first-time collaboration for the Partnership Program with a non-governmental organization, the Alfred P. Sloan Foundation. Together with the Sloan Foundation, NOPP funded eight projects under OBIS, which is a part of the Census of Marine Life initiative. OBIS is envisioned to be a distributed network of marine biological and environmental data for use in examining the changes in diversity, distribution, and abundance of marine organisms over time and space. Additional information on OBIS and the Census of Marine Life can be found online at <http://www.coml.org>. The University-National Oceanographic Laboratory System (UNOLS) and the Naval Oceanographic Office again developed a comprehensive \$3M ocean survey schedule using academic research vessels to address validated Navy survey requirements. That survey schedule can be found in Appendix 1a.

Meetings

The Under Secretary of the Navy chaired the National Ocean Research Leadership Council meeting on May 22, 2000. The minutes of that meeting are included in Appendix 2a. The NORLC agreed to establish the interagency Ocean.US Office for ocean observations to implement the preliminary steps towards an integrated, sustained ocean observing and prediction system. The NORLC also tasked the ORAP with developing an agenda for the study of marine biological resources within the 200-nautical mile U.S. Exclusive Economic Zone, together with the means to make these resources ecologically and economically sustainable by 2010.

The Ocean Research Advisory Panel met April 26, 2000. Minutes of that meeting are included in Appendix 3a.

Ocean.US

In response to a Congressional request for “a plan to achieve a truly integrated ocean observing system,” the report “Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System” was prepared in April 1999 by a joint federal/non-federal Task Team. A follow-on report developed by the ORAP, “An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan” was delivered in December 1999 and contained a set of implementing recommendations. In May 2000, based on the ORAP report recommendations, the NORLC initiated action to establish an interagency Ocean.US office to develop a national capability for an integrated and sustained ocean observation system. The creation of the Ocean.US Office was announced at the May 25, 2000 joint hearing of the House Resources Subcommittee on Fisheries, Conservation, Wildlife, and Oceans and the Armed Services Subcommittee on Military Research and Development.

The Ocean.US Office will serve as the national focal point for integrating ocean-observing activities. As a first order of business, Ocean.US is charged to develop and maintain a long-range vision for an integrated ocean observation and prediction federation. This plan will serve as the conceptual foundation for the federation and will fully describe agency roles to realize the desired goal of a fully integrated and sustained national ocean observation and prediction capability. The Office will also ensure integration of the elements of the observing system; recommend enhancements to existing systems, new projects, and needs for research and development; and identify system components suitable to transition from research to operations. The office began operation on October 25, 2000 and progress will be discussed in the FY 2002 NOPP Report to Congress.

Education

NOPP continues to support five innovative education projects involving, directly or indirectly, contact with thousands of educators and tens of thousands of students. This suite of projects is creating a foundation for a national marine education infrastructure involving new and effective partnerships between educators and scientists. Additional information and links to these projects can be found on the NOPP web site at <http://www.nopp.org>.

In May 2000, NOPP entered into a partnership with Consortium for Oceanographic Research and Education (CORE) to sponsor future National Ocean Sciences Bowl (NOSB) events. The Terms of Reference for this partnership can be found in Appendix 4. NOSB is a national academic competition for high school students on ocean science topics. The Ocean Science Bowl competition is intended to increase knowledge of the oceans on the part of high school students, their teachers and communities. An additional, and equally important, goal is to raise the visibility and public understanding of the national investment in ocean-related research. The 19 finalist teams for 2001 will compete in the NOSB finals being held in conjunction with the Oceanology International Americas meeting in Miami, FL, April 1-3, 2001. Additional information on the NOSB can be found online at <http://www.nosb.org>.

NOPP funding, in addition to in-kind support from member agencies, continues to support Project NOPP Drifters. This ongoing scientific and educational effort introduces data from ocean drifters

into the K-12 classroom through a specially designed and user-friendly web site. Drifter data in near-real time and more detailed project information are available to educators, scientists and the public at <http://drifters.doe.gov>. Project NOPP Drifters was featured in the June 23-28, 2000 syndicated cartoon “Judge Parker” as a result of the cartoonist’s child accessing data from the project web site.

Federal Oceanographic Facilities Committee

The Federal Oceanographic Fleet Coordination Council (FOFCC) has historically coordinated fleet planning and operations for federal agency oceanographic research vessels. In November 1999, the FOFCC was renamed the Federal Oceanographic Facilities Committee (FOFC) and chartered under NOPP. Composed of federal oceanographic facilities managers, FOFC advises the NORLC on policies, procedures, and plans relating to oceanographic facility use, upgrades, and investments. The committee also provides guidance on requirements and other matters relative to national oceanographic assets. The Charter for FOFC is at Appendix 5.

IV. FISCAL YEAR 2001 ACTIVITIES

The FY 2001 Program

The FY 2001 Partnership Program Research Solicitation (Broad Agency Announcement) again mirrors the Partnership Program focus towards an integrated ocean observing and predicting system. This system will consist of a ‘federation’ of many elements to support a wide range of users.

The FY 2001 NOPP Broad Agency Announcement (BAA) was issued December 20, 2000. Proposals are due May 1, 2001. That solicitation can be found at Appendix 6. The Program construction for FY 2001 will again employ a competitive peer-reviewed process and be approved by the NORLC.

Additionally, the Department of Commerce (NOAA), on behalf of NOPP, issued a request for preliminary proposals (Letters of Intent) and subsequent full proposals for implementing the next phase of the U.S. contribution to the global Argo array of profiling floats. Argo is a broad-scale global array of temperature/salinity profiling floats that is planned as a major operational element of Ocean.US. The complete solicitation is included in Appendix 7.

The Navy also issued a FY 2001 Small Business Innovative Research (SBIR) solicitation associated with NOPP. Proposals are sought to develop a modular, affordable, yet expandable autonomous system, linking data from a variety of platforms in parallel with the developing Ocean.US integrated ocean-observing system. That solicitation can be found at Appendix 8.

A comprehensive ocean survey schedule using academic research vessels to address validated Navy survey requirements was developed by UNOLS and the Naval Oceanographic Office. The survey schedule as of 1 February 2001 is included in Appendix 1b.

Meetings

The National Ocean Research Leadership Council met on October 16, 2000. Minutes of that meeting are included in Appendix 2b. The NORLC approved the Interagency Working Group request to develop and implement the Ocean.US Memorandum of Agreement (MOA). This Agreement defines first steps and outlines the initial functions and responsibilities agreed by the participating agencies to establish the interagency Ocean.US Office. Ocean.US will serve as the national focal point for integrating ocean observing activities that meet specified needs of the participating agencies. The complete MOA is included in Appendix 9.

The NORLC endorsed Department of State and U.S. Army Corps of Engineers participation in the Council meetings. All concerned agreed that the experience and expertise of the Department of State and the U.S. Army Corps of Engineers will strongly contribute to the goals of the Partnership Program. The Department of State and the Army Corps both sent senior level representatives to the October 2000 NORLC meeting.

The NORLC charged the Interagency Working Group to prepare a briefing on the Partnership Program to the President's Commission on Ocean Policy. This briefing may also be used for the Pew Ocean Commission.

The Ocean Research Advisory Panel met October 3, 2000. Minutes of that meeting are included in Appendix 3b. In response to the NORLC request for a national strategy for marine biology research, the ORAP agreed to build on and synthesize the many available studies, stakeholder inputs and ongoing programs to describe a broad framework for a U.S. research agenda over the next decade, to be revisited periodically. Two areas were specifically addressed: 1) ecological sustainability, including the marine food web, impact of pollution on living marine resources, and tools for management and conservation of living and non-living marine resources, and 2) economic sustainability, including marine biotechnology and health of marine fisheries and research on marine organisms. The resulting report, "Strategic Vision for Achieving Sustainable Marine Resources within the U.S. EEZ" lists important first steps in making progress in marine biological research. These steps include:

- 1) expanding programs to characterize coastal ecosystems and monitor their response to intentional and unintentional perturbations using all relevant biological, chemical, and physical sensors;
- 2) improving methods of data collection, management, and dissemination across government agencies and between public and private sectors;
- 3) investing in biological and chemical sensor research, to bring these systems to the same level of maturity and reliability as the current suite of physical sensors; and
- 4) supporting the development of joint coastal ocean circulation and ecosystem models.

The complete report can be found in Appendix 10 and is available on the NOPP web site at <http://www.nopp.org>. The ORAP and the Ocean.US Office will continue to develop this strategy further.

The inaugural meeting of the newly formed Federal Oceanographic Facilities Committee [FOFC] was held 29 November 2000. The Committee agreed to draft a federal interagency strategy for the future of the national academic fleet. This strategic plan was requested by the National Science Board and is intended to guide federal government agencies, academia and Congress in maintaining

and enhancing the academic fleet. The draft is currently undergoing agency and community review and an update will be presented to the NORLC in the Spring of 2001.

New ORAP Members and Balance of Membership

Three new members joined ORAP in FY 2001:

Dr. Marcia McNutt, President and Chief Executive Officer of the Monterey Bay Aquarium Research Institute;

Mr. Lawrence Dickerson, President and Chief Operating Officer of Diamond Offshore Drilling, Inc.; and

Dr. Denise Stephenson-Hawk, Chair of the Stephenson Group, a consulting firm in Atlanta, GA.

The Panel is currently seeking two additional members to represent industry, specifically the commercial fisheries and the oil services sector.

Current panel members include the current President of the National Academy of Sciences, a past NOAA Chief Scientist, a current Commissioner of the U.S. Marine Mammal Commission, leaders of four major atmospheric/oceanographic educational and research institutions, senior representatives from the for profit private sector, a State government representative involved in marine resource management, and a representative from the environmental law community. Members are listed in Appendix 11.

V. FISCAL YEAR 2002 PLANS

The NOPP investment portfolio has steadily expanded and is now reflected in the budget of the following seven NOPP Agencies: Navy, NOAA, NSF, NASA, MMS, USGS, and USACE. Each of these agencies plan direct investments in one or more of the five NOPP investment areas, while the remaining NOPP Agencies have identified NOPP related research contributing to the basic investment strategy.

V. FISCAL YEAR 2002 PLANS

The NOPP investment portfolio has steadily expanded and is now reflected in the budget of the following seven NOPP Agencies: Navy, NOAA, NSF, NASA, MMS, USGS, and USACE. Each of these agencies plan direct investments in one or more of the five NOPP investment areas, while the remaining NOPP Agencies have identified NOPP related research contributing to the basic investment strategy.

Policy decisions on the FY 2002 Budget have not yet been finalized; therefore specific programmatic issues and funding levels are not identified. However, NOPP will likely continue to support the existing five investment areas:

- Operational/Routine Observations;
- Research "Observatories";
- Observational Technique Development;

- “Commons” for Ocean Information;
- Outreach/Education.

VI. INTERAGENCY COORDINATION ACTIVITIES

The central tenet and expanding role of NOPP is interagency cooperation. The most recent activities (Ocean.US, the Federal Oceanographic Facilities Committee, and the National Ocean Sciences Bowl) are described in previous sections of this report. A large number of additional existing and emerging efforts are moving under the NOPP umbrella. This list of cooperative efforts is dynamic and changing and a full updated description can be found on the NOPP web site at <http://www.nopp.org>.

APPENDIX 1

Fiscal Year 2000 and 2001 NOPP funded University-National Oceanographic Laboratory System (UNOLS) Academic Ship Survey Schedules

1a - FY 2000 Academic Ship Survey Schedule

Ship	Institution	Dates	Days	Location
CAPE HATTERAS	Duke University/ University of North Carolina	3/24-4/08 8/21-9/05	32	Florida Coast
ENDEAVOR	Univ of Rhode Island	2/15-3/08	23	East Coast
LONGHORN	University of Texas	3/16-4/15	32	Gulf of Mexico
NEW HORIZON	Scripps Institution of Oceanography	3/29-4/2 4/15-4/23 11/01-11/15	29	Southern California
PELICAN	LUMCON	1/27-2/12 5/02-5/16 8/30-9/13 12/02-12/16	62	Gulf of Mexico
WALTON SMITH	Miami	3/02- 3/21 11/01-11/15	35	Gulf of Mexico

1b - FY 2001 Academic Ship Survey Schedule (This table reflects scheduled days as of 1 February 2001.)

Ship	Institution	Dates	Days	Location
CAPE HATTERAS	Duke University	1/31-2/15 9/19-10/4	30	Onslow Bay
LONGHORN	University of Texas	6/3-6/17 9/13-9/28	30	Gulf of Mexico
NEW HORIZON	Scripps Institution of Oceanography	2/9-3/4 5/20-6/1 7/18-8/1	52	California Coast
REVELLE	Scripps Institution of Oceanography	2/25-3/25	29	Hawaii
SEA DIVER	Harbor Branch Oceanographic Institution	7/15-8/1	18	Gulf of Mexico
SEWARD JOHNSON	Harbor Branch Oceanographic Institution	3/26-4/9	15	Gulf of Mexico
SPROUL	Scripps Institution of Oceanography	2/2-2/16	15	California Coast
WALTON SMITH	University of Miami	1/5-1/29	25	Gulf of Mexico

APPENDIX 2a

National Ocean Research Leadership Council 22 May 2000 Meeting Minutes

6 June 2000

MEMORANDUM FOR THE RECORD

Subj: MINUTES OF THE 22 MAY 2000 NATIONAL OCEAN RESEARCH LEADERSHIP COUNCIL MEETING

1. These are the minutes of the seventh National Ocean Research Leadership Council (NORLC) meeting held in the Truman Room of the White House Conference Center, 726 Jackson Pl., Washington, DC on 22 May 2000.

The Chair called the meeting to order at 2:05 p.m. The following NORLC members or their representatives were present:

Mr. Jerry Hultin, representing the Secretary of the Navy (Chair)
Dr. D. James Baker, Under Secretary of Commerce for Oceans and Atmosphere (Vice-Chair)
Dr. Margaret Leinen, representing the Director, National Science Foundation
Dr. Ghassem Asrar, representing the Administrator, National Aeronautics and Space Administration
Dr. Aristides Patrinos, representing the Deputy Secretary, Department of Energy
Dr. Darrell Brown, representing the Administrator, United States Environmental Protection Agency
Rear Admiral Kenneth Venuto, representing the Commandant, United States Coast Guard
Dr. Charles Groat, Director, United States Geological Survey
Captain Albert C. Myers, USN, representing the Director, Defense Advanced Res. Projects Agency
Mr. Walter Rosenbusch, Director, Minerals Management Service
Dr. Rosina Bierbaum, representing the Director, Office of Science and Technology Policy
Mr. Gary Reisner, representing the Director, Office Management and Budget

2. Opening Remarks

The Chair welcomed all participants, asked all attendees to introduce themselves, and introduced Dr. Steven E. Ramberg, Chair of the NOPP Interagency Working Group (IWG), to describe the Consent Calendar Agenda items.

3. Consent Calendar

Four Consent Calendar items were approved as presented:

- Approve FY00 NOPP Awards - Proposals received in response to the NOPP FY00 Broad Agency Announcement have been reviewed by four review panels (one for Topics A1 and A2 – Planning and implementation of a ‘Virtual Ocean Data Hub’ (VODHub) activity and Planning and implementation of a Pilot Project to broaden access to data from the Navy Sound Surveillance System (SOSUS), one for Topic A3 – Implementation of several additional ‘nodes’ for data assimilation and modeling activities, one for Topic B – Ocean Biogeographical Information System (OBIS), and one for Topic D – Renewal of FY97

Education Projects) and, to a lesser extent, by external peer reviewers. The review panels have provided the IWG with a list of projects recommended for funding. The IWG held a special meeting to review and discuss the recommendations from the panels and, as a result of this meeting has prepared a package recommended for funding. The IWG seeks NORLC approval of this package.

- Approve Charter/Terms of Reference for the Federal Oceanographic Facilities Committee (FOFC) as a new NOPP committee under NORLC. Charge FOFC to review NSF/ONR/NOAA fleet planning and report back at Fall NORLC meeting regarding NOPP role(s) in fleet activities - The Federal Oceanographic Fleet Coordination Council (FOFCC) was created many years ago to coordinate fleet planning and operations among the oceanographic research vessels of different agencies. At its 8 November, 1999 meeting, FOFCC voted to accept an invitation extended by the IWG on behalf of the NORLC to join NOPP. At its 6 December, 1999 meeting, the NORLC agreed to establish FOFCC as a new NOPP committee under the NORLC. The IWG has been working with FOFCC to bring the Council into NOPP and rename it as the Federal Oceanographic Facilities Committee (FOFC). A Charter/Terms of Reference for FOFC has been developed and is ready for approval by the NORLC. NSF, ONR, and NOAA are currently preparing a fleet plan, and the IWG suggests that this plan to be assessed by FOFC for potential NOPP role(s). The IWG therefore requests that FOFC be charged with reviewing the NSF/ONR/NOAA fleet plan and reporting back to the NORLC at its Fall meeting on NOPP role(s) in fleet activities.
- Enter into a partnership with the Consortium for Oceanographic Research and Education (CORE) to sponsor future National Ocean Sciences Bowl (NOSB) events and also seek additional sponsoring partners from the private sector - CORE, along with its 58 member institutions and in partnership with the National Marine Educators Association (NMEA), conducts the annual NOSB competition. NOSB is an academic competition for high school students that focuses on ocean-related topics. This competition is intended to increase knowledge of the oceans on the part of high school students, their teachers and parents, as well as to raise the visibility and public understanding of the national investment in ocean-related research. Each year, teams winning the regional tournaments held around the nation qualify to participate in the final competition in Washington, D.C. Many NOPP agencies including, NASA, NOAA, NSF, the Navy, and USGS provide financial support for the NOSB. Private sponsors have included The David and Lucile Packard Foundation, Lockheed Martin, US Airways Group & Meeting Travel, and Anteon Corporation. The IWG suggests that NOPP enter into a partnership with CORE to sponsor future NOSB events under NOPP auspices and seek additional sponsoring partners from the private sector.
- Form a Selection Committee to develop nominations for the next Chair and Vice Chair of the NORLC. Confirmation of the nominees would be placed on the agenda of the Fall, 2000 NORLC meeting - NOPP legislation states that "...the chairman and vice chairman of the Council shall be appointed every two years by a selection committee of the Council composed of, at a minimum, the Secretary of the Navy, the Administrator of the National Oceanic and Atmospheric Administration, and the Director of the National Science Foundation. The term of office of the chairman and vice-chairman shall be two years. A person who has previously served as chairman or vice chairman may be reappointed." The terms of the current Chair and Vice Chair end following the Fall, 2000 NORLC meeting and

both have served two terms. It is therefore time to form a Selection Committee to develop nominations for the next Chair and Vice Chair. The IWG suggests that this Selection Committee be composed of Navy, NOAA, NSF, NASA, and any other interested agencies. Confirmation of the nominees would be placed on the agenda of the Fall, 2000 NORLC meeting following deliberations over the summer.

4. NOPP Status Report

A. NOPP Program Update and FY00 Plans

Dr. Ramberg provided a brief overview of the current program. Information was provided on the FY 2000 NOPP Broad Agency Announcement (BAA) including the number of projects recommended for funding under each topic. NOPP FY 2001 plans, ship surveys and NOPP funding distribution by sector over the last four years were also discussed. A higher success rate for FY 2000 proposals was noted and attributed to the narrower scope of the FY 2000 NOPP BAA.

The NORLC expressed concern over the decline in industry participation. Dr. Ramberg commented that the IWG anticipates this trend to be countered by increased industry representation on the Ocean Research Advisory Panel (ORAP) and through potential industry involvement in the integrated ocean observing system. NOPP participation in the Oceanology International Americas meeting in Miami, Florida in 3-5 April, 2000 will also serve as a venue for outreach to industry.

There was also a question regarding future plans for the ship surveys. The goal has been to get funds for the survey work, which had been a Congressional add-on, included in the Navy budget. Dr. Ramberg noted that the University-National Oceanographic Laboratory Systems (UNOLS) vessels used in the surveys cannot work the highest priority of backlog surveys due to security issues.

Dr. Stan Wilson, Vice Chair of the IWG, provided a brief overview of the special issue of *Oceanography* magazine dedicated to NOPP. The issue will feature ten articles authored by the investigators of a wide variety of NOPP-funded projects and is intended to highlight the diversity of the Partnership Program. We will explore whether the entire issue can eventually be posted on the NOPP web site.

B. Ocean Research Advisory Panel Update

Dr. John Knauss, Chair of the NOPP ORAP, provided a brief report on the activities of the ORAP and their meeting of 26 April 2000. Dr. Knauss reported that the ORAP is pleased to see increased funds from more NOPP agencies contributing to projects and increased grant lengths for some FY 1999 and FY 2000 NOPP-funded projects. Future ORAP activities will include a review of NOPP grants to date and a survey to determine if there is an advantage to or a synergy created by a program such as NOPP. The ORAP will also track the development of the integrated ocean observing system. Dr. Knauss noted that the ORAP is pleased to see the idea of an interagency coordinating office for the system being embraced. This was a recommendation put forth by the Panel in its report "An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan." Dr. Knauss cautioned that throughout the system development process, the

need to allow for and anticipate changes, innovations, and integration in the system must be recognized.

The NORLC asked Dr. Knauss if the ORAP would be interested in expanding its responsibilities beyond physical oceanography issues to biological and chemical research. Rosina Bierbaum stated that the Office of Science and Technology Policy would like the ORAP to develop a strategic biological research agenda, in the form of a white paper, that would call out the gaps, emerging questions, and grand challenges in biological research in the ocean. The purpose is to determine if ocean resources are being used wisely and the type of research that the ocean sciences community should be doing in order to ensure responsible and sustainable use of ocean resources 10 to 15 years from now. Such a white paper would be needed by the end of the calendar year so it could be used as a transition document for the new administration. Other members of the Council commented that issues such as the chemical and biological aspects of the integrated ocean observing system, fisheries management, and biotechnology should also be considered. Dr. Baker commented that such a tasking would involve the ORAP undertaking a broader scope than usual. Dr. Knauss stated that the ORAP would be interested in pursuing this issue provided that the exact scope of the task to the Panel were specified and clearly stated. He also expressed concerns about the deadline for a report being the end of the calendar year and whether the ORAP has the level of expertise necessary to undertake this task. As a result of the discussion, the Council tasked the IWG to examine the general topic of a biological research agenda for the oceans and determine the focus and direction the ORAP should take in addressing the issue.

5. National Ocean Conference Follow-Up Actions

Dr. Ken Turgeon of the Minerals Management Service provided a briefing on the activities of the Ocean Report Task Force co-chaired by the Chair of the Council on Environmental Quality, George Frampton, and the Deputy National Security Advisor, James B. Steinburg. This Task Force was formed to take action on recommendations from the June, 1998 National Ocean Conference as put forth in the Conference follow-up report *Turning to the Sea: America's Ocean Future*. The goal of the Task Force is to develop a limited number of high visibility action plans that address key topics from the Conference and the report and can be announced by the end of the current administration. The Task Force is currently working towards refinement and implementation of the shortened list of action plans.

6. Integrated Ocean Observing System

Dr. Ramberg briefed the NORLC on the work in progress to implement an integrated, sustained ocean observing and prediction system that would serve as a way for users to access oceanographic knowledge, data, tools, and products. Creating a federation of existing and new observations and data management elements through an interagency "OCEAN.US" office is proposed as an initial step under NOPP. The NORLC authorized the IWG to establish this coordination office and proceed with the preliminary steps as outlined. These steps would include drafting an overarching MOA for the federation and the office, beginning to establish linkages of Navy/NOAA operational observational efforts, beginning to establish linkages among ongoing NOPP efforts relevant to the federation; and assessing the role(s) of research "observatories" and a modeling/assimilation "commons."

7. Other Business

Dr. Baker and the rest of the NORLC thanked ADM James Watkins, President of the Consortium on Oceanographic Research and Education (CORE), for his years of work in supporting and raising the visibility of ocean sciences on the national agenda. ADM Watkins will retire from CORE later this year.

The meeting was adjourned at 3:45 p.m. The next meeting of the NORLC will be in Fall 2000. At this meeting, the IWG will report on program activities and progress of the OCEAN.US office.

8. Summary of Approvals/Actions:

Approved:

1. All items on the Consent Calendar.
2. Establishment of the OCEAN.US office and implementation of the preliminary steps towards an integrated, sustained ocean observing and prediction system.

For Action:

- The IWG will examine the general topic of a biological research agenda for the oceans and determine the focus and direction the ORAP should take in addressing this issue.

APPENDIX 2b

National Ocean Research Leadership Council October 16, 2000 Meeting Minutes

23 October 2000

MEMORANDUM FOR THE RECORD

Subj: MINUTES OF THE 16 OCTOBER 2000 NATIONAL OCEAN RESEARCH
LEADERSHIP COUNCIL MEETING

1. These are the minutes of the seventh National Ocean Research Leadership Council (NORLC) meeting held in the Truman Room of the White House Conference Center, 726 Jackson Pl., Washington, DC on 16 October 2000.

The Chair called the meeting to order at 2:05 p.m. Mr. Pirie welcomed representatives from the Department of State and the Army Corps of Engineers. Agency representatives are listed below:

Mr. Robert Pirie, Under Secretary of the Navy (acting Chair)
Dr. D. James Baker, Under Secretary of Commerce for Oceans and Atmosphere (Vice-Chair)
Dr. Rita Colwell, Director, National Science Foundation
Dr. Ghassem Asrar, representing the Administrator, National Aeronautics and Space Administration
Dr. Anna Palmisano, representing the Deputy Secretary of Energy
Dr. Norine Noonan, representing the Administrator, U.S. Environmental Protection Agency
CAPT Charles Lancaster, representing the Commandant, United States Coast Guard
Dr. Suzette Kimball, representing the Director, United States Geological Survey
Mr. Tom Green, representing the Director, Defense Advanced Research Projects Agency
Dr. Thomas Kitsos, representing Director, Minerals Management Service
Mr. Duncan Moore, representing the Director, Office of Science and Technology Policy
Ms. Jennifer Baffi, representing the Director, Office of Management and Budget
Dr. L.E. Link, representing the Army Corps of Engineers
Dr. Harlan Cohen, representing the Department of State.

2. Opening Remarks

The Chair welcomed all participants and asked Dr. Steven E. Ramberg, Chair of the NOPP Interagency Working Group (IWG) to summarize the agenda and proposed action items. Due to a scheduling conflict requiring his early departure, Dr. D. James Baker, Under Secretary of Commerce for Oceans and Atmosphere, requested a reordering of the agenda so that he would be present during the discussion of certain topics. All agreed.

3. OCEAN.US/Integrated Ocean Observing System

At the 22 May 2000 meeting, based on the ORAP Report implementation recommendations, the NORLC approved the establishment of an Office having the charter to develop a national capability for integrating and sustaining ocean observations and predictions. Dr. Ramberg reviewed the structure of OCEAN.US and explained that the signatories of the MOA will constitute a subset of the NORLC and comprise the OCEAN.US Executive Committee (Excom). In response to a

question as to why the OCEAN.US Office and the NOPP Program Office are not co-located, Dr. Ramberg explained that this was done so that the OCEAN. US Office would be clearly identified as a new entity.

The Memorandum of Agreement (MOA) to set up the OCEAN.US Office has been extensively reviewed in the agencies. The approved MOA was available at the meeting so those agencies prepared to sign could do so.

4. Administration Transition Planning

The NORLC discussed the need to get information on NOPP, the NORLC, and the ORAP to the Administration transition teams, the Pew Oceans Commission and the 'Oceans Act' Commission on Ocean Policy. Dr. Baker commented that this is an opportunity to build on the current Congressional interest in ocean issues and that it is vital to keep the momentum going. The NORLC charged the IWG to put together a plan to brief the transition teams and the two commissions. The briefing for the commissions should describe what NOPP is, its successes, and its vision for the future. This would then be used as the basis for the briefing to each of the relevant transition teams, including science and technology, national security, and the environment. Dr. Baker suggested the ORAP should consider briefing the commissions and the transition teams. Dr. John Knauss, ORAP Chair, stated that he plans to send a letter to both commissions offering the services of ORAP. The IWG will work with the ORAP on how to best interact with the commissions and the teams. Dr. Baker recommended that preparation for NOPP interaction with the Commission on Ocean Policy should be on the agenda for the (Spring, 2001) NORLC meeting.

5. Consent Calendar

The Chair asked Dr. Ramberg to describe the Consent Calendar items.

- Nominees for the next Chair and Vice Chair of the NORLC - NOPP legislation states that "...the chairman and vice chairman of the Council shall be appointed every two years by a selection committee of the Council composed of, at a minimum, the Secretary of the Navy, the Administrator of the National Oceanic and Atmospheric Administration [NOAA], and the Director of the National Science Foundation [NSF]. The term of office of the chairman and vice-chairman shall be two years. A person who has previously served as chairman or vice chairman may be reappointed." The terms of the current Chair and Vice Chair end following this NORLC meeting and both have served two terms. At its 22 May 2000 meeting the NORLC agreed to form a Selection Committee to develop nominations for the next Chair and Vice Chair. This Selection Committee, composed of Navy, NOAA, NSF, the National Aeronautics and Space Administration, and the Minerals Management Service, has been deliberating on a slate of nominations for the next Chair and Vice Chair. Confirmation of these nominees was scheduled to be an agenda item for Fall 2000 NORLC meeting. However, due to the upcoming change in Administration, it is recommended that consideration of new nominees be postponed until Spring 2001
- Implement OCEAN.US Memorandum of Agreement when signed -. The OCEAN.US Memorandum of Agreement (MOA) defines the first steps and outlines the initial functions and responsibilities agreed to by the participating agencies to establish the interagency ocean

observations office/organization known as the OCEAN.US Office. The Office will serve as the national focal point for integrating ocean observing activities that meet specified needs of the participating agencies. The IWG requests approval to proceed with MOA implementation once the Agreement is signed.

- NORLC membership for the Department of State and the U.S. Army Corps of Engineers - In order to capture the experience and expertise of additional Federal agencies involved in ocean and coastal research and policy, the IWG has invited the Department of State (DoS) and the U.S. Army Corps of Engineers (USACE) to become members of the NOPP IWG. Both have accepted the invitation and appointed representatives. Participation of DoS and USACE in the NORLC was discussed informally at the 22 May 2000 NORLC meeting and raised at subsequent Congressional Hearings. Along with the agencies currently represented on the NORLC, DoS and USACoE are welcome to participate at the Council level. The IWG recommends membership for DoS and USACoE.
- Approve FY 2001 NOPP solicitations - The IWG is developing solicitations to fund projects beginning in FY 2001. Topics will follow the NOPP programmatic themes. This year we expect to emphasize Topic A: Operational/Routine Observations (Argo); Topic B: Research "Observatories" (TBD); Topic C: Observational Technique Development (minor); Topic D: "Commons" for Ocean Information Network (more nodes); and Topic E: Education/Outreach (not this year). Proposals will be due in the January, 2001 timeframe. The IWG requests approval to release the NOPP FY 2001 solicitations.

The four Consent Calendar items were approved as presented.

4. NOPP Status Report

A. NOPP Program Update and Plans

Dr. Ramberg provided a brief overview of the current program. Information was provided on the structure of the program, including the OCEAN.US Excom and the Federal Oceanographic Facilities Committee. Program activities to date and FY 2001 plans were also discussed. Dr. Ramberg ended the status report with a review of the five NOPP topics (operational/routine observations; research "observatories"; observational technique development; "commons" for ocean information; and education and outreach) including the projects and amount of funding in each. The information provided was for NOPP-funded activities only. The ORAP requested a similar overview of NOPP-coordinated activities.

B. Ocean Research Advisory Panel (ORAP) Update

Dr. Knauss provided a brief report on the activities of the ORAP and their meeting of 3 October 2000. Proposed new members in the final stages of the clearance process attended the meeting, including Dr. Marcia McNutt of the Monterey Bay Aquarium Research Institute, Mr. Lawrence Dickerson of Diamond Offshore Drilling, Inc. and Dr. Denise Stephenson-Hawk of The Stephenson Group. The Panel hopes to establish a formal rotation process in the near future.

Dr. Knauss reported that the ORAP is delighted with the progress of OCEAN.US. and noted the office was a Panel recommendation in its report “An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of U.S. Plan.”

Panel members discussed the need for an in-depth review of ongoing NOPP programs. It was agreed that specific ORAP members would directly track/review specific NOPP topical areas and provide commentary regarding the status of their topic to the panel. Members noted the need to present success stories to illustrate the value of the program such as NOPP and the need to determine how the transition from research to the operational mode will be made within NOPP.

At its 22 May 2000 meeting, the NORLC, at the request of the Office of Science and Technology Policy, tasked the ORAP to develop a strategic vision for a U.S. research program to study marine biological resources within the U.S. Exclusive Economic Zone and to work with the OCEAN.US office to determine appropriate observational strategies in support of the research program. Dr. Knauss reported that a subcommittee of ORAP met 25-26 September 2000 to respond to this tasking. The subcommittee focused more on the second part of the task, and developed a preliminary report. This report deals with observations in the coastal ocean and the fact that the kind of observational network the community wants and needs in the coastal ocean does not exist. Dr. Knauss commented that it is worthwhile to invest in the instruments needed for such a coastal observation system. A response to the first part of the tasking statement will be drafted by Dr. McNutt, with assistance from Dr. Robert Gagosian of the Woods Hole Oceanographic Institution.

The NORLC commented that integrated coastal observations are important and that the ORAP should keep in mind that coastal states collect much data and should be considered allies of the federal agencies in this effort. The Council also expressed concern that the ORAP develop and maintain a dialogue with operators and researchers in the field actually collecting the data.

C. Federal Oceanographic Facilities Committee (FOFC)

Dr. Margaret Leinen of the National Science Foundation and Chair of FOFC presented an overview of FOFC, including information on the plan for management of the academic fleet currently being developed by the Committee. The plan will be presented to the NORLC at its Spring 2001 meeting for approval. In response to a question from the Council, Dr. Leinen reported that the plan is advisory in nature, but each relevant agency was involved in its development. It therefore contains information on the needs, roles, etc. of these agencies with regard to the fleet. Dr. Leinen further noted that this plan provides the direction and general architecture of the future academic fleet, addressing the concerns within the oceanographic community regarding at-sea research facilities. The plan will be reviewed by both the agencies and the oceanographic community.

In response to a question from the Council, Dr. Leinen commented that the plan's focus is on the fleet, rather than other tools and techniques, in keeping with the request for a fleet plan. She noted that the NORLC might request a future plan focusing on other oceanographic facilities.

RADM Richard D. West, Oceanographer of the Navy, and RADM Jay M. Cohen, Chief of Naval Research, stated that this discussion on ship needs is a key demonstration of why NOPP is so important. The program brings together the various interests and needs of the different agencies. This is especially vital for presenting a cohesive unit to Congress, rather than individual agencies.

There was considerable discussion regarding national research capabilities in ice covered waters. It was agreed that dedicated research time aboard Navy nuclear submarines is critical to the success of future arctic research. ADM Watkins pointed out the cost of space-borne remote sensing platforms is comparable to costs associated with operating a nuclear submarine.

Dr. Rita Colwell, Director of the National Science Foundation, commented that the administration transition is an opportunity for the agencies to get together to make things happen in a way not done before.

The NORLC charged the IWG to work with FOFC to include information on the preservation of oceanographic facilities in the transition teams and commissions briefing. This information should be presented in the context of a larger, long-range plan. A draft from the FOFC is due prior to the next NORLC meeting in Spring 2001. The next FOFC meeting is planned for November 2000.

7. Other Business

On behalf of Dr. Baker, Dr. David Evans of the NOAA Office of Oceanic and Atmospheric Research thanked the agencies for providing staff to work on the Ocean Exploration Panel. He expects the final report to be complete by the deadline.

Mr. Pirie and the rest of the NORLC thanked ADM James Watkins, President of the Consortium on Oceanographic Research and Education (CORE), for his years of work in supporting and raising the visibility of ocean sciences on the national agenda. ADM Watkins will retire from CORE in the coming months.

The meeting was adjourned at 3:45 p.m. The next meeting of the NORLC will be in Spring 2001. At this meeting, the IWG will report on program activities and progress of the OCEAN.US office.

8. Summary of Approvals/Actions:

Approved:

- All items on the Consent Calendar.

For Action:

- The IWG will prepare a briefing to present to the Administration transition teams and the Pew and Commission on Ocean Policy. The IWG will work with the ORAP on how to best interact with the teams and commissions.
- The IWG will work with the FOFC to include information on preservation of oceanographic facilities in the transition teams and commissions briefing.
- The IWG will prepare an overview of NOPP-coordinated activities.

APPENDIX 3a

Ocean Research Advisory Panel 26 April 2000 Meeting Minutes

National Oceanographic Partnership Program

OCEAN RESEARCH ADVISORY PANEL

Meeting Minutes

26 April, 2000

Somers Room, The Brookings Institution

Washington, D.C.

I. Welcome/Opening Remarks

The fourth meeting of the Ocean Research Advisory Panel of the National Oceanographic Partnership Program was opened at 9:00 a.m. on 26 April, 2000 with a welcome from the Chair John Knauss. Members present and representatives from the NOPP Agencies, the Partnership Program Office and the National Academy of Sciences are listed below.

Attendees

Name

Organization

Members

John Knauss (Chair)	University of Rhode Island
Robert Frosch (Vice Chair)	Harvard University
Vera Alexander	University of Alaska, Fairbanks
Rick Anthes	University Corporation for Atmospheric Research
Otis Brown	University of Miami, RSMAS
Robert Gagosian	Woods Hole Oceanographic Institution
David Keeley	State of Maine Coastal Zone Mgmt Program
Patrick K. Sullivan	Oceanit Laboratories, Inc.
Steve Ramberg	ORAP Designated Federal Official/ Office of Naval Research

Others

Jon Berkson	United States Coast Guard
Mel Briscoe	Office of Navy Research
Muriel Cole	Nat'l Oceanic & Atmospheric Administration
Cynthia Decker	Consort. for Oceanographic Research & Education
Morgan Gopnik	National Academy of Sciences
Roxanne Nikolaus	Consort. for Oceanographic Research & Education
Richard Pittenger	Woods Hole Oceanographic Institution
Thomas Nelson	Office of Naval Research
Michael Reeve	National Science Foundation
Nicole Ricci	Office of the Oceanographer of the Navy
Kathy Shield	Office of the Oceanographer of the Navy
Rick Spinrad	Office of the Oceanographer of the Navy
Ken Turgeon	Minerals Management Service
James Watkins	Consort. for Oceanographic Research & Education

Stan Wilson
Robert Winokur

Nat'l Oceanic & Atmospheric Administration
Consort. for Oceanographic Research & Education

II. Review of Agenda

Panel Chair John Knauss and the Panel Federal Official, Steve Ramberg of the Office of Naval Research reviewed the agenda.

III. NOPP Program Update

A. Program Progress Report

Following a Program update by S. Ramberg, the Panel asked about the funding contributions to NOPP from agencies other than Navy. They expressed concern that Navy not be the sole contributor to the Program and were pleased to learn that the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA) have budgeted funds for NOPP. The Panel endorsed specific Navy, NOAA, NSF and NASA NOPP budget requests for FY 2001. The Panel questioned involvement by the remaining NOPP agencies, and S. Ramberg suggested that once NOPP moves more toward operational activities, all agencies will become more active in the Program.

The Panel recommended that an analysis of budgets related to NOPP be done that would include for each Fiscal Year:

- Specific agency funding budgeted/programmed for NOPP
- Identification of non-Federal funding dollars identified for NOPP
- Identification of Federal agencies, non-fed organizations and Grantees listing in-kind NOPP funding and cost-share funds for NOPP.

During a review of the FY 2000 proposal selection, the Panel questioned the success rate for NOPP proposals. S. Ramberg reported that there is a significantly higher percentage of successful proposals in FY 2000 and focused Program solicitations should continue this positive trend. The panel requested an analysis of the success rate for new starts in FY2000 separate from the analysis for all FY 2000 funded proposals, which includes renewal projects. The Panel asked if the funding for FY 2000 projects contained any new money for ocean sciences. The agency representatives present reported that some of the funding is new money (e.g., NOAA's \$3 million for Argo) and represents an increase in those agencies' budgets.

S. Wilson briefed the Panel on the up-coming NOPP issue of *Oceanography* magazine that will feature articles on varied NOPP-funded projects. The Panel was pleased to hear about the issue. This discussion prompted J. Watkins to ask the Panel to consider how public relations and communications efforts for NOPP should be undertaken. Currently, NOPP communications activities are handled through the NOPP Program Office and the Consortium for Oceanographic Research and Education.

B. National Ocean Conference Follow-up

K. Turgeon provided a briefing on the activities of the Ocean Report Task Force co-chaired by the Chair of the Council on Environmental Quality, George Frampton, and the Deputy National

Security Advisor, James B. Steinburg. This Task Force was formed to take action on recommendations from the June, 1998 National Ocean Conference as put forth in the Conference follow-up report *Turning to the Sea: America's Ocean Future*. The current focus is to narrow down the 147 recommendations to a limited number of high visibility action plans that can be accomplished by the end of the current administration. The Task Force is scheduled to meet in early May to review and finalize the shortened list of action plans. The Panel expressed concern that this progress may be lost once the new administration is in place. The tasking for NOPP is pending, but a significant NOPP role is anticipated.

S. Wilson provided a briefing on Argo, including a summary of statistics and status of international involvement and commitments. There are currently 270 floats funded, with 2270 floats proposed over the next three years. The intention is to keep the program going indefinitely, which would require 750 floats per year, assuming an average float lifetime of four years.

C. Army Corps of Engineers and Department of State participation in NOPP

S. Ramberg reported that the U.S. Army Corps of Engineers and the Department of State have accepted the invitation to become formal members of the NOPP Interagency Working Group.

IV. Integrated Ocean Observing System (IOOS) Update

S. Ramberg briefed the Panel on the work in progress to implement an integrated, sustained ocean observing and prediction system that would serve as a way for users to access oceanographic knowledge, data, tools, and products. A federation of existing and new observations and data management elements through an "OCEAN.US" Office is proposed as an initial step under NOPP. The goal is to have the implementation plan far enough along by the 22 May, 2000 meeting of the NOPP National Ocean Research Leadership Council to get the Council's consent to proceed with the plan.

The Panel endorsed the phased implementation approach of the OCEAN.US concept, and suggested a 'Master IOOS Federation Document' construct rather than a series of Memoranda of Understanding [MOU] between agencies to implement OCEAN.US. They agreed that IOOS/OCEAN.US presents an opportunity to fund/incorporate cutting edge technology. The Panel noted that IOOS/OCEAN.US has potential to expand significantly beyond current plans and could likely have a major role in shaping national policy. J. Knauss noted that the IOOS will continually have new elements added to it, and there needs to be a systematic way to do this.

V. Federal Oceanographic Facilities Committee and ORAP Role in Fleet Matters

S. Ramberg briefed the Panel on the history of the Federal Oceanographic Fleet Coordinating Council (FOFCC) and its transition to the Federal Oceanographic Facilities Committee (FOFC) under NOPP. The new FOFC Charter and tasks were discussed. The Panel expressed concern over how "facility" is defined and questioned whether all ocean-related structures will have to answer to this group or whether it would just focus on ship issues. The ORAP role would be to provide private sector research and industry advice to the Committee. The Panel applauded FOFC plans to deliver five year Fleet Plan to NORLC in spring 2001, and endorsed FOFC reporting directly to NORLC and coordinating directly with ORAP.

VI. AGU/ASLO 2000 Ocean Sciences NOPP Meeting Summaries

S. Ramberg briefed the Panel on the NOPP Principal Investigator Gathering and NOPP Town Meeting held at the 2000 Ocean Sciences Meeting in San Antonio, Texas 24-28 January, 2000. The focus of the Principal Investigator Gathering was to discuss lessons learned from partnering. The Panel was pleased to hear feedback regarding enhanced coordination among Principal Investigators from research institutions and the new connections between technicians and engineers.

An additional comment from the Principal Investigators at the Gathering was the need for a longer funding period. The Panel discussed the concept of five-year NOPP research grants and were in favor of the idea citing the decreased burden on the community resulting from longer funding periods. Such five-year NOPP projects would be subject to critical review, however, and deliverables must be demonstrated. The 5-year grant issue generated considerable discussion regarding a 5-year fiscal program for science. J. Watkins asked the Panel if the Consortium for Oceanographic Research and Education should push for five-year agency budgeting on Capitol Hill and raised the question as to whether NOPP could be a pilot for this. Although serious administrative issues must be addressed and overcome, the concept of a 5-year Presidents Budget Request [PBR] for NOPP was strongly endorsed by the Panel.

VII. Climate Research

R. Gagosian led a discussion on how well the atmospheric and oceanographic communities work together, especially in the area of modeling. He raised the question whether researchers in these two communities do work together and exchange needed data. All agreed that communication between the oceanographic and atmospheric research communities was much improved, but there is room for additional improvement.

R. Gagosian identified four primary areas of concern:

A. Large scale ocean circulation models (GCM) - R. Gagosian noted that communication and interaction in this area seems to be on track, but there is a need for air-sea flux data not currently available. The balance between in-situ and remote sensing data was discussed. The Panel also thought this was on the right track but that employing new quasi-operational systems is major issue.

B. Ocean - Atmosphere Coupled Models – The Panel agreed that cooperation in this area is improving. The time period between generations of atmosphere models is at least two years. This lag in introducing new science is a real issue.

C. Cloud Resolving Techniques/Parameterization – The Panel agreed that modelers enjoy a good connectivity with researchers in this area and that the interaction is good. This good coupling sets an example for communication/coordination in other areas of research.

D. Data Assimilation – R. Gagosian noted that this is an area where coordination could be better. There is good data assimilation in the atmospheric community, and atmospheric modelers are employing more advanced data assimilation techniques than their ocean modeler counterparts. The Panel agreed that the oceanographic community needs to do a better job of accessing this data and

was pleased to learn that two of the proposals recently selected for NOPP funding focused on data assimilation.

S. Ramberg suggested that this issue of communication and cooperation between the oceanographic and atmospheric communities could be a topic for the special NOPP sessions planned for the Symposium on Integrated Observing Systems at the 2001 American Meteorological Society Meeting next January.

VIII. Public Comment Period

The general public submitted no comments on ORAP discussions.

IX. Other Business

The Panel agreed that the next ORAP meeting will be scheduled for 3 October, 2000 in Washington, D.C.

X. Adjourn

The meeting was adjourned at 2:15 p.m.

APPENDIX 3b
Ocean Research Advisory Panel 3 October 2000 Meeting Minutes

National Oceanographic Partnership Program
OCEAN RESEARCH ADVISORY PANEL
Meeting Minutes
3 October, 2000
Choate Room
Carnegie Endowment for International Peace
Washington, D.C.

I. Welcome/Opening Remarks

The fifth meeting of the Ocean Research Advisory Panel (ORAP) of the National Oceanographic Partnership Program (NOPP) was opened at 9:00 a.m. on 3 October, 2000. New members Dr. Marcia McNutt, Dr. Denise Stephenson-Hawk and Mr. Lawrence Dickerson were welcomed. Members present and representatives from the NOPP Agencies, the Partnership Program Office and the National Academy of Sciences are listed below.

Attendees

Name

Organization

Members

John Knauss (Chair)	University of Rhode Island
Robert Frosch (Vice Chair)	Harvard University
Vera Alexander	University of Alaska, Fairbanks
Al Beeton	University of Michigan
Lawrence Dickerson	Diamond Offshore Drilling, Inc.
Robert Gagosian	Woods Hole Oceanographic Institution
David Keeley	State of Maine Coastal Zone Mgmt Program
Marcia McNutt	Monterey Bay Aquarium Research Institute
Joel Reynolds	Natural Resources Defense Council
Denise Stephenson-Hawk	The Stephenson Group/Spelman College
Patrick K. Sullivan	Oceanit Laboratories, Inc.
Steve Ramberg	ORAP Designated Federal Official/ Office of Naval Research

Others

Jon Berkson	United States Coast Guard
Bill Birkemeier	U.S. Army Corps of Engineers
Muriel Cole	Nat'l Oceanic & Atmospheric Administration
Cynthia Decker	Consort. for Oceanographic Research & Education
Patrick Dennis	Office of Naval Research
Morgan Gopnik	National Academy of Sciences
David Hilmer	Consort. for Oceanographic Research & Education
Eric Lindstrom	National Aeronautics and Space Administration

Thomas Muir	Office of Science and Technology Policy
Thomas Nelson	Office of Naval Research
Roxanne Nikolaus	Consort. for Oceanographic Research & Education
Martin Offutt	National Academy of Sciences
Michael Purdy	National Science Foundation
Nicole Ricci	Office of the Oceanographer of the Navy
Lisa Rom	National Science Foundation
Kathy Shield	Office of the Oceanographer of the Navy
Anne Tenney	National Science Foundation
James Watkins	Consort. for Oceanographic Research & Education
Stan Wilson	Nat'l Oceanic & Atmospheric Administration
Robert Winokur	Consort. for Oceanographic Research & Education

II. Review of Agenda

Panel Chair Dr. John Knauss and the Panel Designated Federal Official, Dr. Steve Ramberg of the Office of Naval Research, reviewed the agenda (see Appendix). The minutes of the April 26, 2000 Panel meeting were approved.

III. NOPP Program Update

The Chair of the NOPP Interagency Working Group (IWG), S. Ramberg, updated the Panel on Program activities and reported that the Department of State (State) and the U.S. Army Corps of Engineers (Army Corps) have expressed interest in joining NOPP. State and Army Corps representatives have been invited to participate in the October 16, 2000 National Ocean Research Leadership Council (NORLC) meeting. An overview of NOPP research was presented with a progress assessment of each research project. Briefing materials are included in the Appendix. The Panel noted the need to insure that project renewals fit long-term NOPP goals and expressed concern regarding how those NOPP projects designed to be part of the Integrated Ocean Observing System will transition from research to operational use. The Panel requested suggestions for a transition mechanism be presented at the next ORAP meeting. The Panel further commented that NOPP should establish a mid-term review practice for the 5-year NOPP projects. Further, the Panel requested an analysis for planning purposes of the investment made by local and regional governments in data collection, such as data generated by the Environmental Protection Agency and the Army Corps. Following this discussion, S. Ramberg invited the ORAP members to sign up to "track" one or two of the five NOPP categories, including: Topic A: Operational/Routine Observations; Topic B: Research "Observatories"; Topic C: Observational Technique Development; Topic D: "Commons" for Ocean Information Network; and Topic E: Education/Outreach. Member preferences are listed below. S. Wilson noted that there is also an opportunity for an ORAP member to be involved in the educational component of the Argo project.

In a discussion of education and outreach, the Panel agreed that the ocean science community does not do a good job of making the general public aware of the importance of the oceans. There is a need to infuse ocean science information into education programs and keep the information flowing after the initial impact. Teachers and textbook editors both need to be involved in assessing what educational techniques work. D. Stephenson-Hawk volunteered to review this issue and report at the next Panel meeting.

IV. National Science Foundation Proposed Center for Ocean Science Education Excellence

L. Rom of the National Science Foundation (NSF) discussed the recent NSF-sponsored workshop on developing a Center for Ocean Science Education Excellence (COSEE) and the resulting report recommendations. The effort to develop such a center is driven by a need for coordinated national leadership in ocean science education. Workshop participants recommended that: 1) COSEE serve as the national coordinator for ocean science education in the U.S. and 2) COSEE foster collaborations between people and between organizations. Briefing materials are included in the Appendix. M. Purdy, NSF, commented that COSEE would likely become an interagency effort if it is a success after the modest initial steps. ORAP members commended the COSEE effort, while some suggested that the NSF priority in ocean science education should be to demonstrate the relevancy of the oceans to the general public.

V. OCEAN.US/Integrated Ocean Observing System

S. Ramberg led a discussion regarding the integrated ocean observing system effort referred to as OCEAN.US and reported the associated interagency Memorandum of Agreement (MOA) is currently undergoing review in the agencies. This MOA describes the responsibilities and authority of an interagency OCEAN.US office to coordinate the transfer, assimilation and management for oceanographic data. The MOA also describes an Executive Committee (Excom), composed of NORLC members, that will oversee the office. Responding to a Panel query, it was pointed out there is no requirement to sign the MOA, but agencies that do sign and provide significant resources become members of the OCEAN.US Excom. Resources are defined as funds, personnel, and/or observational resources/data. Briefing materials are included in the Appendix.

Following the brief, the ORAP questioned the process to determine what and how agency data is provided to OCEAN.US. S. Ramberg reported the expectation is that agencies will provide those data with a request that the Excom direct OCEAN.US to include those data in OCEAN.US. How or what information is contained in OCEAN.US is not specified in the MOA, but the Distributed Oceanographic Data System (DODS) has been chosen as the data format. The ORAP endorsed this concept. Panel members expressed concerns over the process for data archeology/rescue and suggested that this issue be a principal responsibility of the OCEAN.US office. The ORAP requested to be updated on a regular basis as to the status of OCEAN.US. The MOA and an update on OCEAN.US activities will be sent to the Panel once the Agreement has been signed.

VI. ORAP Tasking from NORLC/OSTP

At its 22 May 2000 meeting, the NORLC tasked the ORAP to:

- a) prepare a strategic vision for a U.S. research program to study marine biological resources within the U.S. Exclusive Economic Zone (EEZ), and
- b) work with NOPP's OCEAN.US Office to determine appropriate observational strategies in support of the research program.

The initial draft response prepared by a subcommittee of the ORAP generated a lively discussion. Panel members generally agreed that the subcommittee response, while a good start, did not fully address the question and focused on Part B of the tasking statement. J. Knauss reported the subcommittee felt that current instrumentation is inadequate to measure biological and chemical parameters in the coastal ocean. M. Offutt, formerly of the Office of Science and Technology Policy (OSTP), reiterated that OSTP would like a white paper that lists marine biological research priorities within the U.S. EEZ and that could be used to push for an increase in ocean research funding, rather than a purchase order for hardware. He suggested that the ORAP should develop the strategic vision now, and another group would flesh out the vision and add monetary information at a later time. J. Knauss commented that prioritizing the research issues already presented in numerous other reports perhaps may not be the best role for ORAP.

M. McNutt suggested that ORAP could highlight relevant questions and issues regarding marine biological research in the coastal ocean as put forth in existing reports from the National Academy of Science, the National Science Foundation, and others in order to confirm priorities. The ORAP agreed that this would be something the Panel could do by the end of calendar year 2000 deadline. M. McNutt volunteered to lead this effort. Members noted that a timeline should be attached to the research strategy highlighting the need for an information infrastructure. It was also noted that the goal stated in the full tasking statement to make marine biological resources sustainable by the year 2010 may not be fully realized, though a pilot or testbed on a regional level may be feasible. The ORAP agreed that the response prepared by the subcommittee should be revisited and used as a basis for a more detailed response to Part B of the task.

VII. Public Comment Period

There were no public comments.

VIII. Other Business

The Panel discussed the potential role(s) of ORAP, the NORLC, and NOPP in general in the Pew Ocean Commission and the National Ocean Commissions. Panel members agreed that ORAP should offer any assistance needed. J. Knauss will draft a letter to the National Ocean Commission offering the ORAP's assistance as appropriate, and will respond as appropriate to any requests from the Pew Ocean Commission.

J. Knauss raised the issue of Panel membership and Chair and Vice-Chair positions. After discussion, it was agreed that the Panel Chair and Vice-Chair election would be a first order of business at the Spring 2001 meeting, which is scheduled for 26 April 2001 in Washington, D.C.

IX. Adjourn

The meeting adjourned at 3:00 p.m.

APPENDIX 4

National Ocean Sciences Bowl Terms of Reference

Terms of Reference for a Partnership between the Consortium for Oceanographic Research & Education and the National Oceanographic Partnership Program in Support of the National Ocean Sciences Bowl

The National Ocean Research Leadership Council approved entering into a partnership with CORE to sponsor future NOSB events and also seek additional sponsoring partners from the private sector. The placement of the National Ocean Sciences Bowl (NOSB) under the National Oceanographic Partnership Program (NOPP) is viewed favorably by CORE because it is seen as a vehicle for stabilizing and sustaining a large base of the funding for this program while providing an additional venue for promoting the program. Since CORE relies upon formal partnerships with its member institutions and informal partnerships with the Sea Grant College Program and the National Marine Educators Association to implement the NOSB program, moving the NOSB under the aegis of NOPP is in keeping with a key NOPP requirement for NOPP-supported projects. The terms of reference for formally establishing the National Ocean Sciences Bowl as a NOPP-sponsored program are listed below.

1. NOSB will continue to be the intellectual property of CORE and its member institutions.
2. NOSB will continue to be managed by CORE nationally and its member institutions regionally, independent of the contract for the NOPP Office.
3. The NOSB will continue to be funded by grants. CORE will contribute to NOSB, as appropriate, to facilitate expansion of the program.
4. Inclusion of the NOSB in NOPP does not preclude CORE seeking funding from other agencies (NOPP or non-NOPP), private foundations, academia, or corporations in support of this program.
5. NOPP agencies will provide a base of support for NOSB that will be augmented by grants from non-NOPP agency sources noted in #4. This support will be provided through a multi-year grant to CORE that will be reviewed annually by the NOPP IWG members or their designees. Only NOPP agencies that financially support NOSB can approve changes to the direction of this program. All NOPP agency participants will be encouraged by the NORLC to participate in the funding support.
6. NOPP agencies contribution to the NOSB will be considered a contribution to NOPP as well.
7. IWG members will help CORE identify the appropriate individuals to approach within their agencies for coordination and support.

8. CORE will provide the staff to coordinate and manage the NOSB, augmented by volunteers/detailees from the NOPP agencies.

APPENDIX 5

Federal Oceanographic Facilities Committee Charter

CHARTER/TERMS OF REFERENCE of the FEDERAL OCEANOGRAPHIC FACILITIES COMMITTEE

A. Official Designation

This Committee will be officially designated the Federal Oceanographic Facilities Committee (referred to hereinafter as FOFC).

B. Objectives and Scope of Activity

The FOFC shall advise the NORLC on policies, procedures, and plans relating to oceanographic facility use, upgrades and investments. It will also provide guidance on matters relating to national oceanographic asset requirements as well as other responsibilities that the Council considers appropriate.

The facilities under consideration will include, but are not limited to major federal assets, such as; oceanographic ships, submersibles, ROVs, AUVs, and maritime research aircraft. FOFC will also provide guidance, input, and direction as necessary for other systems used in ocean observations such as moorings, drifters, observatories and their impact on the utilization and mix of federal facilities.

C. Membership

The FOFC is composed of representation from the NOPP agencies that manage federal oceanographic facilities. FOFC members are the senior agency officials who are responsible for oceanographic facilities policy and management.

The Chairperson of the FOFC will be selected on a rotating basis for a 2-year term from the federal agencies that fund or operate major oceanographic facilities: National Oceanic and Atmospheric Administration (NOAA), Department of the Navy, and the National Science Foundation (NSF). The Executive Secretary will be provided by the agency of the Chairperson.

FOFC may interact with and receive ad hoc advice from various private sector groups as consistent with federal regulations. Non-voting representatives from the University-National Oceanographic Laboratory System (UNOLS) or other oceanographic organizations may also be invited to attend Committee meetings.

D. Description of Duties for Which the Federal Oceanographic Facilities Committee is Responsible

1. Advise the NORLC and the ORAP on policies and procedures relating to facility development, use, and mix from a national perspective.

2. Advise the Council and ORAP on issues dealing with oceanographic facilities, such as;

a. Review the operations, management methods, and capabilities of federal oceanographic facilities and, when appropriate, recommend common standards and approaches to assist federal oceanographic facility managers;

b. Improve planning, coordination, and communication among federal oceanographic facility managers;

c. Address interagency programmatic and operation questions of facilities management;

d. Provide a forum for the exchange of information on long-range plans regarding the construction, deactivation or chartering of oceanographic vessels; and,

e. Monitor international oceanographic facility activities for potential application to the federal facility mix.

3. Any additional responsibilities that the NORLC considers appropriate;

E. Number and Frequency of Committee Meetings

The FOFC shall meet at least twice a year on dates agreeable for the majority of members. The FOFC may establish sub-committees composed of less than the full membership of the FOFC for purpose of carrying out the Committee's duties, subject to the review and control of the Committee. The Executive Secretary of the FOFC prepares minutes of the meeting and distributes to members with a copy to the NOPP IWG.

F. Termination Date

None (Continuing).

APPENDIX 6

Fiscal Year 2001 National Oceanographic Partnership Program Broad Agency Announcement

Fiscal Year 2001 National Oceanographic Partnership Program BAA
(As published in Commerce Business Daily, December 18, 2000)
(Printed Issue Date: December 20, 2000)

PART: U.S. Government Procurements

SUBPART: Services

CLASSCOD: A—Research and Development

OFFADD: Office of Naval Research, 800 North Quincy St., Arlington, VA 22217-5660

SUBJECT: A—National Oceanographic Partnership Program

SOL: 01-005

POC: Mr. Brian Glance ONR Code 252, (703) 696-2596

DESC:

On behalf of the National Oceanographic Partnership Program (NOPP) the Office of Naval Research (ONR) solicits proposals addressing a variety of Partnership Programs as outlined in Title II, subtitle E, of Public Law 104-201 of September, 1997, the National Oceanographic Partnership Program. Up to \$20M (over 5 yrs) may be available for this announcement subject to appropriation and final approval by the National Ocean Research Leadership Council (NORLC). Proposals are due 1 May 2001. Team efforts among academia, industry, and government participants are required (at least 2 of 3). Cost sharing or proposals augmenting ongoing partnership efforts are very strongly encouraged.

Background: The Partnership Program has as its central focus an integrated and sustained ocean observation system which will be achieved by a federation of many elements that can support a wide range of users. We have termed this federation, "Ocean.US". The genesis for this initiative was the publication of the NOPP report "Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System" in April 1999 and the subsequent report on management approaches for such a system. These reports are available at the NOPP website (NOPP.org). To begin this initiative, NOPP selected a few efforts in 1999 that enhanced modeling and data assimilation capabilities via hub-node' activities and by initiating the Array for Real-time Geostrophic Oceanography (ARGO) system development and deployment in a phased manner. In 2000, NOPP continued with other hub-node' elements and also began to support additional elements of the federation including a Virtual Ocean Data Hub' (VODHub) and related data access activities. We view the NOPP investments in five areas:

- A) Operational/Routine Observations (including pilots, testbeds, etc.)
- B) Research “Observatories” (long-term experiments and data series, etc.)
- C) Observational Technique Development (sensors and platforms)
- D) “Commons” for Ocean Information (“hubs” and “nodes”, etc.)
- E) Outreach/Education

and will seek proposals in these areas as described below. Not all NOPP solicitations will seek proposals in all areas (e.g. - we will not seek proposals this year in Topics B (Research Observatories) or E (Outreach/Education). These investment areas are more fully described at www.nopp.org where examples of ongoing NOPP efforts are also listed by these areas. The NOPP website will contain the most recent information.

Topic A. Operational/Routine Observations.

This topic covers operational observation efforts including demonstrations and pilot projects that can lead to a new operational capability, if successful. In this solicitation we seek proposals for a pilot demonstration as described below. We anticipate a separate announcement of opportunity will be released shortly to further the development and deployment of the ARGO observational system.

Satellite-derived Ocean Surface Vector Wind and Sea Surface Topography Operational Demonstration. We have a maturing research capability to observe and utilize satellite-derived ocean surface vector winds and sea surface topography data in various algorithms and models. We would like to demonstrate potential benefits of a comparable capability within the operational community to improve existing products or to generate new products. NOPP therefore plans to support at least two “operational demonstration” projects. One or more projects will be funded in the area of ocean surface vector winds and one or more in the area of sea surface topography. These measurement capabilities are currently supported in a research mode by NASA, and many agencies support research utilizing this data. While some efforts have begun to explore new and improved operational products from this data, NOPP wishes to accelerate development and operational demonstration of data products and operational services using these data sources. Successful proposals will have meaningful participation and partnerships involving both research and operational entities. Each project must quantify the value added by satellite-derived ocean surface vector wind and/or sea surface topography data to the delivery of operational services in the U.S. Approximately \$2.5M is available to support 2 to 4 projects in the range of \$250K to \$400K each per year for up to 3 years.

Topic B. Research “Observatories”

This includes partnership efforts to field ocean observational efforts such as long-term basic research experiments or data series that may evolve into operational elements of an Ocean.US federation. The challenge here is to propose efforts that embrace networking and broad accessibility to all derived data in real-time or near real time. No proposals are solicited at this time for this topic.

Topic C. Observational Technique Development Partnership efforts are sought here to develop and/or demonstrate new ocean observational capabilities to establish the means for continuous, high-resolution measurements of oceanic processes. For this solicitation the emphasis is on further technology developments for the family of ARGO floats and similar observational platforms.

Float Technology development. A pilot program for ARGO was awarded through in 1999 to prepare for implementing the U.S. contribution to the global-scale float deployments and the real-time data handling system. In August 2000, NOAA augmented deployment of U.S. ARGO floats by providing funds for an additional 132 floats for the U.S. contribution to the global array. NOPP intends to add floats later in FY2001 via a separate solicitation. NOPP wishes to continue the technical development of these floats to be used in future ARGO deployments so that continually improving scientific and operational data can be returned from the network. We anticipate that developments for this purpose can also be used in other autonomous devices and observing instruments. A challenge for these projects is to achieve the necessary goal of real-time data reporting and to link with the modeling community on the effect of these observing system(s) components or strategies on the research and operation model outputs. An additional challenge is linking the global array to a coastal observing system. Proposals are requested in the following areas:

- Development of a prototype ARGO float that contains a broader sensor suite (e.g. - optical, acoustic, biological and/or chemical sensors), is capable to 2000m depth but of programmable depth excursions, and possibly ice-hardened for deployment in high latitudes.
- Innovative concept development and tradeoff analyses for a robust, low cost communication system that can achieve real-time reporting or data relay from autonomous elements (e.g. floats) of the ocean observing system.
- Concept studies to explore specific implementation strategies of combined autonomous systems for linking the ARGO network to coastal and continental shelf observing system in the U.S. waters. Systems that utilize autonomous vehicles, gliders, floats, and real-time reporting networks are of interest. [There is also a NOPP SBIR topic open until 10 Jan 2001, see www.nopp.org for information].
- Observing system studies that examine optimizing strategies for profiling depth, reporting interval, parameter accuracy, float life, profile rate, and energy budgets are of interest. Proposers are encouraged to link these studies to those of the Global Ocean Data Assimilation Experiment (GODAE) and determine the impact of the tradeoffs on the data assimilation methods and resulting simulation quality that would emerge from global data assimilation products (both operational and research) (details on GODAE may be found at <http://www.bom.gov.au/bmrc/mrlr/nrs/oopc/godae/homepage.html>).

All participants selected under this topic are expected to establish strong collaborative interactions between the existing ARGO Consortium and NOPP modeling nodes as appropriate. It is envisioned that this research will contribute strongly to the development of an ocean observing system, both global and coastal, and to GODAE. To foster these collaborations, all investigators selected for awards may be expected to participate in periodic workshops. Approximately \$1M is available to support 1 to 2 projects in the neighborhood of \$100K per year for 2 years in each of the above areas.

Topic D. “Commons” for Ocean Information

This subject includes partnership efforts to develop or federate new online infrastructure (e.g. - numerical methods & models) for wide user access. This includes “hubs” and “nodes” offering various capabilities, holdings and community support. These will promote the development of community models and modeling capabilities, efficient and effective data assimilation and data management systems, improved access to a wider variety of data, and a basis for user-derived advances and products. The challenges for proposers in this topic are two-fold. First is to develop the partnerships and rationale for Ocean.US elements of wide community interest. Second is to

develop concepts that maximize flexibility and utility of a hub-node federation for the future. Specific proposals sought with this solicitation are:

(D1) Implementation of several additional nodes' for data assimilation and modeling activities. Partnership efforts are sought to continue a community-wide effort of building a linked system of resources and collaborations for ocean modeling and data assimilation leading to new insights and synthesis of results with broad utility to the ocean community. The genesis for this initiative is a series of workshops in 1997 and 1998, which illuminated the need for an Ocean Research Synthesis and Modeling Program (ORSMP). Four initial nodes were discussed by Powell (1998). In no particular order, these are in the areas of: (1) the coastal ocean; (2) coupled physical-biological models, (3) marine biogeochemistry, and 4) ocean general circulation/climate. Specific examples within these general areas are also cited in the report. NOPP has begun to fund elements of this in 1999 and again in 2000, including several planning efforts (see www.nopp.org). A steering committee made up of representatives from these nodal activities and at large members of the ocean science community was formed in 1999 to advise the NOPP agencies on the form and requirements of the future Ocean Information Technology Infrastructure (OITI) needs. The OITI steering committee has been tasked to suggest the essential characteristics of the "hub" to support team activities and the broader ocean community over the next decade and provide recommendations on implementing it. High priority areas are in biogeochemical, ecosystem and integrative coastal or integrative global modeling. By integrative coastal or global modeling we mean integrated models that contain two or more of the following components: physical, biogeochemical, sediment and particle transport, and ecosystem components. Optional but desirable attributes include the following: data assimilation capability, connectivity to the virtual ocean data hub, and utilization of observing systems. All participants selected under this topic are expected to establish strong collaborative interactions between the existing teams and be willing to contribute to the concept development of a central "hub facility" capable of serving the teams and the broader ocean community. To foster these collaborations, all investigators selected for awards may be expected to participate in periodic workshops. Once selected, these teams will assist NOPP in establishing a virtual ocean model hub ("ModHub") element described below and to work with other "hubs" and "nodes" of the "commons". Under this topic, NOPP will consider proposals for implementation activities ("Phase B studies" from last year's solicitation). NOPP encourages development of partnerships with state and local government agencies, which may be able to ensure operational capability and support for approaches of wide community use. This topic calls for studies in the range of \$500K to \$1M per year each for 5 years with a possibility of renewal for another 5 years. NOPP expects to fund 2 to 4 proposals in this subtopic.

(D2) Planning of a Virtual Ocean Model Hub' ("ModHub") activity as a key element of Ocean.US to broaden and improve access to state-of-the-art ocean models, algorithms and relevant numerical techniques available from all open and credible sources. We envision this activity to be essentially an online catalog/directory/kiosk with added value of benchmark results, a user helpdesk, user feedback and other features of importance. This "hub" will provide user access to the various "nodes" of the federation. The key to success of the "ModHub" will be the ability of a user to easily obtain source code for their use with a minimal documentation and with several test cases so the user can further develop the model/algorithm/code as needed. It is expected that the ModHub will provide modest user support online and that significant upgrades of the software by the users will become part of the growing catalog of holdings in the ModHub or the connected "nodes". It is envisioned that proposers to this element will:

- identify individuals/organizations that will take the lead to collect and maintain the catalog of community-based software; partner with local institutions (public and private) to improve the breadth of the holdings;
- enhance connections to existing national and international software holdings; and
- connect to the existing and future “nodes” of the federation.

The Proposers to this subtopic should assemble a team to spend a year to initially plan these activities in connection with other hub-node’ activities, and then develop implementation methods to accommodate system-wide connections to other key system elements (i.e. other hubs’). We anticipate support of several planning efforts in this area up to \$200K each per year for the first two years and expanding to \$1-2M per year in the outyears as the various holdings and connections are defined and established. The outyear efforts should be proposed as an option so that a single “ModHub” can be selected from the planning efforts.

RENEWAL OF EXISTING NOPP PROJECTS

Currently funded 1998 NOPP partnership efforts can seek an additional funding for one year to “wrap-up” existing efforts and/or to begin transition to other efforts, where appropriate. Review of these efforts will follow the guidelines outlined below, with the additional criterion of accomplishments achieved to date. Proposals must clearly state on their cover sheet that this proposal is a Renewal. We would prefer that NOPP investigators funded in FY1998 give full consideration to a proposal that is congruent with the above topics and propose accordingly. Funding up to \$150K per year will be available for 1 year for these purposes. This topic will remain open for one year but available funds for renewal proposals received after the proposal due date cannot be assured.

General Instructions and Information

Interested offerors are encouraged to submit a notice of intent to propose for the May due date by 1 April, 2001 to the address listed below. A short letter (2 pages or less) that gives the intended title with a description of the subject and a list of the potential partners (by name and affiliation) is sufficient. The purpose for this notice of intent is preparation of peer review activities; please provide data appropriate to determine subject matter experts without conflicts of interests. All proposals will be subject to peer review, which will include non-governmental reviewers. All reviewers will adhere to confidentiality and conflict of interest standards. E-mail or fax submissions will not be accepted. Twenty copies of the proposals are due not later than 4:00PM EST on Tuesday May 1, 2001 to

NOPP BAA/ONR 32
Room 407-8
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5660

Proposals received at ONR after this date and time will not be considered unless it is a renewal of a 1998 NOPP effort. All proposals must indicate the BAA number above and which subtopic area is being addressed (e.g., Topic A, C, D or renewal) on the cover page. Separate proposals must be

submitted for each topic or subtopic area. Adobe Acrobat PDF files of the proposals would be especially welcome, and should accompany the proposals on either a floppy diskette(s) or Iomega Zip disk. E-mail and facsimile materials are not acceptable. No request for proposal (RFP), solicitation, or other announcement of this opportunity will be made. Historically Black Colleges and Universities and Minority Institutions, as determined by the Secretary of Education to meet requirements of 34 CFR Section 608.2 and 10 U.S.C. Paragraph 2323(a)(1)(C), are particularly encouraged to participate.

Evaluations of the proposals will use the following selection criteria:

- (1) relevance of the proposed research to Partnership objectives, including a) support of critical research objectives or operational goals such as data accessibility, education and communication, b) broad participation within the oceanographic community, c) partners with a long-term commitment to the proposed objectives, d) resources are shared among partners, and e) the degree of cost-sharing by partners with the requested Partnership funding,
- (2) overall scientific and technical merits of the proposal,
- (3) the offeror's capabilities, related experience, and facilities or unique combinations of these that are critical to the proposal objectives,
- (4) the qualifications and experience of the proposed principal investigator and key personnel,
- (5) degree of significant partnering among at least two of the following parties, academia, industry or government,
- (6) socio-economic merits of the proposal,
- (7) realism of proposed costs.

A synopsis of the NOPP review process can be found at www.nopp.org.

The final distribution of awards among topics will depend on quality of proposals, programmatic balance, NOPP priorities and availability of funds. Funding estimates for any ship-time must be specifically included in the proposal and the budget should clearly specify the size and type of vessels proposed for use. Ships of opportunity are encouraged. Proposers should include shiptime requests on either the former NSF Form 831 (Shiptime Request Form) or preferably the University-National Oceanographic Laboratory System (UNOLS) on-line request form available at: <http://www.gso.uri.edu/unols/ship/shiptime.html>

For awards made as contracts, the socio-economic merits of each proposal will be evaluated based on the commitment to provide meaningful subcontracting opportunities for small business, small disadvantaged business, women-owned small business concerns, historically black colleges and universities, and minority institutions. The North American Industrial Classification Systems (NAICS) code is 54171 with the small business size standard of 500 employees. In addition, contract proposals that exceed \$500,000 submitted by all but small businesses, must be accompanied by a Small, Disadvantaged and Women-Owned Small Business Subcontracting Plan in accordance with FAR 52.219-9.

Questions regarding contractual matters relating to this BAA should be directed to:

Office of Naval Research
Attention: Mr. Brian Glance (Code 252)
Ballston Towers One
800 N. Quincy St.
Arlington, VA 22217-5660
(703) 696-2596

Technical questions may be submitted by E-mail to "NOPPBAA@ONR.NAVY.MIL" or by fax to "NOPP BAA" (703) 696-2007 if necessary.

CITE: (W-353 SN509166)

APPENDIX 7

NOAA Argo Float Solicitation

Administration, R/OSS2; ATTN: Dr. Stephen R. Piotrowicz; SSMC3, Room 11554; 1315 East-West Highway; Silver Spring, MD 20910.

FOR FURTHER INFORMATION CONTACT: Dr. Stephen R. Piotrowicz at the above address, or at phone: (301) 713-2465 Ext. 124, Facsimile: (301) 713-0158, internet: Steve.Piotrowicz@noaa.gov.

SUPPLEMENTARY INFORMATION:

I. Program Authority

Authority: 49 U.S.C. 44720(b); 33 U.S.C. 883d, 883e; 15 U.S.C. 2904; 15 U.S.C. 2931 et seq., (CFDA No. 11.431)--Climate and Atmospheric Research.

II. Program Description

Background

Argo, a broad-scale global array of temperature/salinity profiling floats, is planned as a major component of the ocean observing system, with deployment scheduled to begin in 2000. Conceptually, Argo builds on the existing upper-ocean thermal networks, extending their spatial and temporal coverage, depth range and accuracy, and enhancing them through addition of salinity and velocity measurements. Argo is designed to have a strong complementary relationship with the Jason altimeter mission. For the first time, the physical state of the upper ocean will be systematically measured and assimilated in near real-time.

The objectives of Argo fall into several categories. Argo will provide a quantitative description of the evolving state of the upper ocean and the patterns of ocean climate variability, including heat and freshwater storage and transport. The data will enhance the value of the Jason altimeter through measurement of subsurface vertical structure ($T(z)$, $S(z)$) and reference velocity, with sufficient coverage and resolution for interpretation of altimetric sea surface height variability. Argo data will be used for initialization of ocean and coupled forecast models, data assimilation and dynamical model testing. A primary focus of Argo is seasonal to decadal climate variability and predictability, but a wide range of applications for high-quality global ocean analyses is anticipated.

The initial design of the Argo network is based on experience from the present observing system, on newly gained knowledge of variability from the TOPEX/Poseidon altimeter, and on estimated requirements for climate and high-resolution ocean models.

All Argo data will be publicly available in near real-time via the GTS, and in scientifically quality-controlled form with a few months delay. Global coverage should be achieved during the Global Ocean Data Assimilation Experiment (GODAE), which together with CLIVAR (CLimate VARIability and Predictability Program) and GCOS/GOOS, provide the major scientific and

operational impetus for Argo. The design emphasizes the need to integrate Argo within the overall framework of the global ocean observing system.

International planning for Argo, including sampling and technical issues, is coordinated by the Argo Science Team. Nations presently having Argo plans that include float procurement or procurement, include Australia, Canada, France, Japan, U.K., and U.S.A., plus a European Union proposal. Combined deployments from these nations are expected to exceed 700 floats per year by 2002.

Funding Availability

This RFP is to implement the NOAA component of the U.S. contribution to Argo. Actual funding levels will depend upon the final FY 2001 budget appropriations. This Program Announcement is for a program to be conducted by investigators both inside and outside of NOAA, over a five year period. It is expected, though not certain, that a single program involving multiple investigators will be funded. In accordance with the NOPP, team efforts among academia, industry, and government participants with cost sharing proposals are very strongly encouraged. For Federal Government investigators, funding will be provided through intra- or interagency transfers, as appropriate. The funding instrument for extramural awards will be a grant unless it is anticipated that NOAA will be substantially involved in the implementation of the project, in which case the funding instrument should be a cooperative agreement. Examples of substantial involvement may include but are not limited to proposals for collaborative between NOAA or NOAA scientists and a recipient scientist or technician and/or contemplation by NOAA of detailing Federal personnel to work on proposal projects. NOAA will make decisions regarding the use of the a cooperative agreement on a case-by-case basis.

III. Eligibility

Eligible applicants are institutions of higher education, other non-profits, commercial organizations, international organizations, state, local and Indian tribal governments and Federal agencies. Applicants from non-Federal and Federal applicants will be competed against each other. Proposals selected for funding from non-Federal applicants will be funded through a project grant or cooperative agreement under the terms of this notice. Proposals selected for funding from NOAA employees shall be effected by an intraagency fund transfer. Proposals selected for funding from a non-NOAA Federal agency will be funded through an interagency transfer. Please Note: Before non-NOAA Federal applicants may be funded, they must demonstrate that they have legal authority to receive funds from another federal agency in excess of their appropriation. Because this announcement is not proposing to procure goods or services from applicants, the Economy Act (31 USC 1535) is not an appropriate legal basis.

IV. Evaluation Criteria

Evaluations of the proposals will use the following selection criteria:

1. Overall technical merits of the proposal, including (20%):
 - a. Deployment strategy, including how the proposed strategy complements and/or supplements other components of the observing system as they relate to operational predictions, as well as to the objectives of CLIVAR and GODAE;

- b. Deployment logistics, including communications as well as deployment; and
- c. Data management.
- 2. Relevance of the proposed program to NOPP objectives of developing a better understanding of oceans and establishing U.S. leadership in oceanography through a formal partnership mechanism including (20%)
 - a. Data accessibility,
 - b. Broad participation within the oceanographic community,
 - c. Partners with a long-term commitment to the proposed objectives;
 - d. Resource sharing among partners, and
 - e. The degree of cost-sharing by partners with the requested Partnership funding.
- 3. The offeror's capabilities, related experience, and facilities or unique combinations of these that are critical to the program's objectives (20%).
- 4. The qualifications and experience of the proposed principal investigator(s) and key personnel (20%).
- 5. The degree of significant partnering among at least two of the following parties: Academia, industry or government (10%).
- 6. Realism of the proposed costs (10%).

V. Selection Procedures

All proposals, including those submitted by NOAA employees, will be evaluated and ranked using the criteria above by: (1) Independent peer mail review, and/or (2) independent peer panel review; both NOAA and non-NOAA experts in the field may be used in this process. The program officer will not be a voting member of an independent peer panel. The results of the peer reviews are provided to the NOPP Interagency Working Group. The NOPP Interagency Working Group determines the proposals to be funded, subject to the concurrence of the National Ocean Research Council (NORLC) for funding. The NORLC reviews and approves a NOPP program at a regular NORLC meeting. An award may be selected outside of the ranking order provided by the peer mail or peer panel reviewers. Reasons for an award outside of the ranking order are logistical (e.g, access to deployment platforms) and timeliness (e.g., it takes an unusually long time, for example, a couple of years from receipt of funding to full deployment of floats supported each year). The Program Manager will also determine the total duration of funding. Unsatisfactory performance by a recipient under prior Federal awards may result in an application not being considered for funding.

APPENDIX 8

Navy Small Business Innovative Research (SBIR) Solicitation

The following Navy Small Business Innovative Research [SBIR] solicitation is specifically associated with the National Oceanographic Partnership Program.

N01-036

TITLE: Remote Data Link for Integrated Ocean Observing System

TPOC: Thomas Nelson

Phone: 703-696-4396

Fax: 703-696 2007

Email: nelsont@onr.navy.mil

2nd TPOC: Steven Ramberg

Phone: 703-696-4358

Fax: 703-696 2007

Email: rambers@onr.navy.mil

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: TESS, NITES, MORIAH - PMW 185.

OBJECTIVE: Significantly reduce the per byte transmittal cost for data from in-situ ocean/atmosphere sensor platforms to shore-based collectors via an innovative, low-cost, modular communications system using extant or projected communication technologies. This is a unique opportunity to concurrently develop a matched communications and observation system by closely connecting with the interagency National Oceanographic Partnership Program [NOPP] Integrated Ocean Observing System [IOOS] recently approved [May 2000] by the National Ocean Research Leadership Council [Navy, NOAA, NSF, NASA and seven other federal agencies].

DESCRIPTION: There is a need for an innovative, inexpensive, relatively high bandwidth communications system to forward remotely sensed unclassified ocean/atmosphere parameters from in-situ platforms to the user in real time. A modular, expandable system initially capitalizing on inexpensive extant facilities [rf, cell phone, satellite] with growth potential to embrace projected cutting edge communications technology is the goal. The challenge is to develop a pioneering, affordable, yet expandable autonomous system, transparent to the user, linking data from a variety of platforms [buoy, mooring, AUV, float, etc] in parallel with the developing NOPP Integrated Ocean Observing System. Fundamental progress will require a strongly coordinated effort between the contractor and the interagency NOPP IOOS Program Office [OCEAN.US]. The goal is inexpensively deliver reliable and accurate environmental parameters from remote in-situ sensors to the public and private sector. These data are central to safety at sea and severe weather warning preparation, and are key drivers employed by defense mission planners/tactical action officers selecting weapons systems and fleet/unit defensive postures.

PHASE I: Develop a detailed design, in parallel with the NOPP OCEAN.US office, for an innovative, stand alone, modular communications system with relatively high bandwidth to inexpensively deliver ocean/atmosphere data from a variety of sensor platforms. Determine the feasibility and costs associated with currently available technologies as well as with projected next-generation communication capabilities. Prepare a risk or cost-benefit analysis comparing the proposed designs with systems currently in use.

PHASE II: Fabricate a prototype communications system using enhanced in-place systems with a growth potential capable of exploiting projected advances in communications technology. Determine scale-up costs at varying bandwidths.

PHASE III: Develop a production and implementation plan for the next-generation ocean/atmosphere in-situ data communications systems. Clearly articulate the transition potential and probable users within the ocean/atmosphere science and operational users, e.g., government [Navy, NOAA], industry [oil patch, pollution monitoring], and the science and education communities.

COMMERCIAL POTENTIAL: There is a significant commercial application for this system. The public and private sector would likely employ such a system for a wide variety of autonomous remote monitoring applications involving safety and warning systems at sea and ashore. Commercial fisheries, cruise ship operators and educators from K-12 through graduate level, et al would benefit from remote environmental sensor data. However, the fundamental user remains the warfighter at sea; efficient employment of precise weapons systems depends on accurate, real time environmental indices.

REFERENCES:

1. National Oceanographic Partnership Program Report "Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System, April 1999
2. National Oceanographic Partnership Program Ocean Research Advisory Panel Report "An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan", December 1999

KEYWORDS: Data; Communication; Sensors; Ocean; Atmosphere; Data Distribution

APPENDIX 9

Ocean.US Memorandum of Agreement

National Oceanographic Partnership Program (NOPP)
MEMORANDUM OF AGREEMENT
For Establishing A
NOPP Interagency Ocean Observation Office

1. **BACKGROUND.** The statutory authority for the National Oceanographic Partnership Program (NOPP), with representatives from twelve (12) Federal agencies, its National Ocean Research Leadership Council (NORLC), and the Ocean Research Advisory Panel (ORAP) is contained in 10 USC 7901 et seq. In response to a Congressional request for “a plan to achieve a truly integrated ocean observing system,” the report “Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System” was prepared by a joint federal/non-federal Task Team. This led to a set of implementing recommendations in the report “An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan” that was delivered in December 1999. On May 22, 2000, based on the ORAP Report implementation recommendations, the NORLC approved the establishment of an office having the charter to develop a national capability for integrating and sustaining ocean observations and predictions. The formation of this OCEAN.US office was jointly announced by the Chief of Naval Research, the Administrator of NOAA, and the President of the Consortium for Ocean Research and Education on May 25, 2000, at a joint hearing of the House Resources Subcommittee on Fisheries, Conservation, Wildlife, and Oceans and the Armed Services Subcommittee on Military Research and Development to examine the status of implementing the recommendations of the ORAP report.

This interagency OCEAN.US Office has as its goal over the next decade to integrate existing and planned elements to establish a sustained ocean observing system to meet the common research and operational agency needs in the following areas:

- Detecting and forecasting oceanic components of climate variability
 - Facilitating safe and efficient marine operations
 - Ensuring national security
 - Managing resources for sustainable use
 - Preserving and restoring healthy marine ecosystems
 - Mitigating natural hazards
 - Ensuring public health
2. **PURPOSE.** This Memorandum of Agreement (MOA) outlines the initial functions and responsibilities agreed to by the participating agencies to establish the interagency ocean observation office/organization known as the OCEAN.US Office. The Office will serve as the national focal point for integrating ocean observing activities.
 3. **AUTHORITY.** This interagency OCEAN.US Office is a functioning entity of, and established under the auspices of, the National Oceanographic Partnership Program, as established by the

National Oceanographic Partnership Act (10 USC 7901 et seq). OCEAN.US functions or actions will not conflict with mission prerogatives or regulatory responsibilities of the participating agencies.

4. DEFINITIONS.

- a. Observation and Prediction System. The integrated ocean observation system will be a heterogeneous, distributed system of linked elements, with organizational structures and interfaces developed where common good is identified (e.g., a federation) in the manner described by “An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan.” OCEAN.US will be the focal point for relating U.S. ocean observing system elements to the international Global Ocean Observing System. The primary purpose is to enhance broad user access to ocean knowledge, data, tools and products. In appropriate cases, the OCEAN.US Office will establish, fund, and provide for the operation of components of the observing system whose functionality cuts across the roles and interests of the individual participating agencies. Examples might include network links, master databases and indexes, or collaborative tools and services. The system, therefore, will be a virtual system, consisting of the physical links, servers, and other elements that contribute to the mission, regardless of their ownership or operational responsibility. The system will comprise four main activities:
- operational and routine ocean observations (“data access”)
 - long-term research observations (“observatories”)
 - technology development to support the OCEAN.US objectives (“tools”), and
 - a web-based “commons” for access to models, algorithms, numerical techniques, etc. to foster improved predictions by the users.

The OCEAN.US Office will integrate and coordinate assigned elements within these four areas. Further, the Office will foster and integrate linkages among the many other agency and partner elements in these areas.

- b. Functioning Bodies. The following bodies are established by this Agreement:

- (1). NORLC OCEAN OBSERVATIONS EXECUTIVE COMMITTEE (EXCOM). The NORLC Ocean Observations EXCOM will be composed of the NOPP Agency heads (or their designees) for the Agencies that are both party to this Agreement and who provide personnel or resources to the OCEAN.US Office. The Chair of the NORLC will designate the Chair of the EXCOM. The Chair of the EXCOM will be from an Agency other than the Chair of the NORLC. With regard to the OCEAN.US Office, the EXCOM will provide policy guidance, ensure sustained Agency support, and approve implementing documents.
- (2). OCEAN.US Office. The OCEAN.US Office will initially establish and have cognizance over the ocean observation federation - as defined above - and, as it evolves over time, other appropriate components of a more encompassing ocean observation and prediction federation as defined by the EXCOM. It will initially have a Director and Deputy Director appointed by the EXCOM and will include other technical representatives from the EXCOM Agencies and a modest administrative/support staff, as appropriate. Other agencies and partners may be

represented at appropriate times through the invitation of the EXCOM or the Office. The Office will function as an official Federal Government office via assignment of its staff from the NOPP Federal Agencies.

- (3). Director of the OCEAN.US Office. The Director of the OCEAN.US Office will be selected by the EXCOM. The selection process will seek to achieve balance across the participating Agencies.

c. Project Categories. Elements of the system may be regarded as “NOPP-funded,” “NOPP-coordinated,” or “NOPP-related.” Elements in the first two categories are to eventually become fully integrated elements of the ocean observation and prediction system by the signatories of this Agreement. NOPP-related elements, while not directly integrated, also can provide valuable data, information, tools or products of interest to the user community.

- (1) NOPP-funded elements are a result of a NOPP solicitation and/or selection process, which is to say, approved by the NORLC and in accordance with overall NOPP objectives. These elements must adhere to the integrating conventions established by the OCEAN.US Office and approved by the NORLC/EXCOM. Once accepted as an element in this category, the sponsoring agency must notify the NORLC of its intent to withdraw.
- (2) NOPP-coordinated elements are ongoing and new activities of one or more NOPP agencies and partners which are offered to the NORLC for integration with the observation system. These elements will adhere to the data access and documentation conventions of the Federation established by the OCEAN.US Office and approved by the NORLC EXCOM at the cost of the offering agency. Once accepted as an element in this category, the sponsoring agency must notify the NORLC of its intent to withdraw.
- (3) NOPP-related elements are ongoing and new activities of agencies and/or adjunct partners (including, for instance, international partnering) which are offered to the NORLC for coordination with the integrated observation system activities.

5. **FUNCTIONS & RESPONSIBILITIES.** This undertaking requires active participation of the involved parties. Further, the Office is of substantive interest in its promotion of collaboration between agencies, in providing information useful for assisting agencies in the development of their budget submissions, and in ensuring compatibility and interoperability.

The EXCOM Agencies will support the OCEAN.US Office by (1) designating agency representative(s), as needed, and/or (2) providing adequate funding support to the Office. Costs for operating the Office intend to be shared among the Agency participants at levels commensurate with their involvement. Each Agency will be responsible for supporting its staff seconded to the OCEAN.US Office. Transfer of funds or personnel for this effort will be made pursuant to other appropriate authorities, agreements or by amendment to this agreement.

The OCEAN.US Office will:

- (1) Develop and maintain a document outlining the long-range vision of an integrated ocean observation and prediction federation. This document will serve as the conceptual

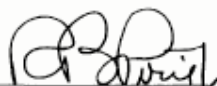
foundation for the federation and will delineate the desired goal of a fully integrated and sustained ocean observation and prediction capability for the nation.

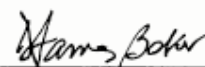
- (2) Ensure integration of the elements of the observing system.
- (3) Serve as the focal point to coordinate OCEAN.US observing system activities with the NOPP Interagency Working Group (IWG), the Ocean Research Advisory Panel (ORAP), and the Federal Oceanographic Facilities Council (FOFC) as well as other federal and non-federal partners, and with the international community.
- (4) Report regularly to the EXCOM for guidance and the IWG for coordination. Provide an annual assessment of the observing system status, products and planned directions including results of external reviews, as appropriate.
- (5) Recommend enhancements to existing systems, new projects, need for research and development, and identification of system components suitable to transition from research to operations.
- (6) Carry out all other tasks as directed by the NORLC.


6. DATA. All NOPP agencies and affiliated partners will provide data required to support OCEAN.US operations, research, and education efforts in accordance with applicable laws, regulations, and policies of the participating agencies.


7. REVIEWS. An initial external review of the OCEAN.US program will be conducted after an appropriate startup period as determined by the EXCOM. Regular external reviews will take place periodically thereafter.


8. PERIOD OF AND PARTIES TO THE AGREEMENT. This MOA, and thus the establishment of the OCEAN.US Office, shall be effective upon signatures from four NORLC Agencies and is subject to availability of funds. It may be modified by mutual agreement of all the parties, usually by the addition of an Appendix or Annex. Signatory parties may terminate their participation with six (6) months formal notice to all other parties via the NORLC. All NOPP agencies are eligible to participate as active parties to this agreement by affixing a signature of the Agency to this MOA. Other governmental organizations and entities may be recognized as adjunct partners to this agreement by consideration and approval of the National Oceanographic Research Leadership Council (NORLC) upon receipt of a signed statement agreeing to the principles of the MOA, as appropriate to that partner.

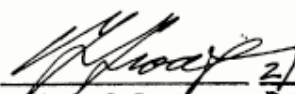
 10/12/00
Robert B. Pirie, Jr. Date
Under Secretary of the Navy
Acting

 10/17/00
Dr. D. James Baker Date
Under Secretary of Commerce
for Oceans and Atmosphere

 10/24/00
Dr. Rita Colwell Date
Director, National Science Foundation

 29 January 2001
Dr. Ghassem Asrar Date
Associate Administrator for Earth Science,
National Aeronautics and
Space Administration

 10/25/00
Mr. Walt Rosenbusch Date
Director
Minerals Management Service
Department of the Interior

 2/1/01
Dr. Charles G. Groat Date
Director
U.S. Geological Survey
Department of Interior

APPENDIX 10

Ocean Research Advisory Panel Report “Strategic Vision for Achieving Sustainable Marine Resources Within the US EEZ”

Introduction

In 2000, the Ocean Research Advisory Panel (ORAP) of the National Ocean Partnership Program (NOPP) was requested by the White House Office of Science and Technology Policy (OSTP) to perform two tasks. The first was to prepare a strategic vision (primary topics and their initial priorities) for a US research program to study marine biological resources within the 200-nautical mile US Exclusive Economic Zone (EEZ). The vision is to include the means to make these resources economically and ecologically sustainable by 2010. ORAP was asked to respond to this request by the end of the calendar year.

The second task is to work with NOPP’s OCEANS.US Office to determine appropriate observational strategies in support of the research program and the sustainability goals of 2010 outlined in the first task. ORAP is asked to respond to this charge by the end of calendar year 2001.

This report is intended to respond to the first of these tasks. ORAP’s view on executing this charge was that any recommendations must be based on sound scientific analysis and backed by strong community support and consensus. Because of the short time available to complete this report, it was not possible to convene panels of experts to craft the recommendations or to submit the report to a lengthy and thorough review process. For that reason, the ORAP relied on a number of recent reports from the National Academy of Sciences (NAS), the National Science Foundation (NSF), the National Ocean and Atmospheric Administration (NOAA), and other groups, all of which had the benefit of expert input and peer review. Conclusions and recommendations taken directly from published reports are referenced in the footnotes. All documents consulted are listed in the bibliography at the end of the report. In many cases the recommendations from these reports were not prioritized, nor had there been an attempt to prioritize the recommendations among different reports. Nevertheless, the ORAP was able to assign initial priorities to the recommendations based on their immediate relevance to the topic at hand, as well as a consideration of what common themes span the full spectrum of coastal resource issues.

Ecological Sustainability

No part of the ocean is unaffected by human activities. Marine ecosystems experience substantial impacts from commercial fishing, aquaculture, introduction of non-native species, destruction of habitat, excess nutrients, and the addition of pollutants¹. The coastal ocean is affected most profoundly, on account of its proximity to a population increasingly concentrated along the shoreline, and the US EEZ is no exception². These effects are manifested increasingly by outbreaks of harmful algal blooms, microbial pathogens, and in some instances, the complete collapse of commercially important invertebrate and fisheries populations. Natural variability due to climate change is also affecting the coastal ocean, but at this time such impacts are smaller in magnitude

¹ *Ocean Ecology: Understanding and Vision for Research*, Report of the OEUVRE Workshop, P. Jumars and M. Hay, Eds., National Science Foundation, 1999.

² *Clean Water Action Plan: Coastal Research and Monitoring Strategy*, The Coastal Research and Monitoring Strategy Workgroup, convened by EPA, NOAA, USDA, and USGS, August, 2000.

than the human influence. However, if the wind systems were to change significantly, coastal circulation and ecosystems could be strongly altered. At the very least, the natural changes can exacerbate the problems induced by human activities³. There is thus an urgent need to understand and predict the factors and subsequent effects leading to the alteration or the collapse of marine communities and the ecosystem services that they provide. Ultimately, strategies must be developed to mitigate the damage to marine ecosystems inflicted by humans and nature.

We focus on three important components of ecological sustainability that require enhanced attention through research and development: research on the interactions and interdependence of the marine food web; research on marine pollution, particularly excess nutrients; and the development of resource management and conservation tools.

Marine Food Web

Better sustaining the biological resources in the coastal EEZ requires a better understanding of the marine food web. Research objectives should include determining the functional and structural dynamics of these biological assemblages and how they respond to environmental perturbations. A better understanding is needed of the linkages between primary and secondary productivity. Also of underlying importance is the need to understand the interactions between marine biota and various biogeochemical cycles, including any influence of global climate change. These interactions can occur from the individual organism level to the ecosystem level. Better mechanistic understanding of these interactions through observation and controlled experimentation is required to meet future threats to marine ecosystems. For example, warming of the surface ocean over the past decade has lessened the upwelling of cold, nutrient-rich waters, leading to a dramatic drop in primary productivity in some coastal areas. Although it is beyond humankind's immediate control to change the temperature of the surface waters throughout the coastal ocean, are there other ways to compensate for this reduction in natural upwelling?

Improved technologies for observing and characterizing the distribution of food web components and their associated interactions across time and space will be required. Extensive time series data from both remote sensing and *in-situ* systems⁴ will be necessary to compensate for the substantial heterogeneity that exists in the marine environment and to improve the resolution of paleontological patterns. Emerging molecular, chemical, optical, and acoustical technologies should lead to significant improvements in remote sensing capabilities. However, a substantial investment is still needed to bring *in-situ* systems to the state such that they can be deployed for long periods on autonomous platforms⁵. It is imperative that that investment be made now such that these systems are ready for deployment on coastal observing systems within the next few years.

Effect of Excess Nutrients on Living Marine Resources

³ *From Monsoons to Microbes: Understanding the Ocean's Role in Human Health*, Committee on the Ocean's Role in Human Health, Ocean Studies Board, National Academy Press, Washington, D.C., 1999.

⁴ *Priorities for Coastal Ecosystem Science*, Committee to Identify High-Priority Science to Meet National Coastal Needs, Ocean Studies Board, National Academy Press, Washington, D.C., 1994.

⁵ *Understanding Marine Biodiversity*, Committee on Biological Diversity in Marine Systems, Ocean Studies Board, National Academy Press, Washington, D.C., 1995. *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*, President's Panel on Ocean Exploration, U.S. Department of Commerce, 2001.

Nutrient (nitrogen) over-enrichment in coastal waters is a complex, priority resource management issue that could be addressed through this marine resource strategy. Nutrient enrichment can have a range of effects on coastal systems. Direct and indirect ecological impacts include increased primary productivity and phytoplankton biomass, reduction in water clarity, increased incidences of low oxygen events, and changes in the food web structure and dynamics. Harmful algal blooms may become more frequent and extensive and the growth of some marine pathogens may be promoted. Coral reefs and submerged aquatic vegetation, such as seagrass and kelp beds may be degraded or destroyed. Fish kills may occur, and more importantly, subtle changes in ecological structure may lead to lowered fishery production. Generally, nutrient over-enrichment leads to ecological changes that decrease the biotic diversity of the ecosystem⁶.

Management strategies must be designed for controlling or mitigating the effects of nutrients. The need for improving the scientific basis for these approaches is pressing. For example, water quality criteria and standards and load levels will need to be established, as well as a system for evaluating the effectiveness of various approaches, such as wetlands restoration or reduced fertilizer applications. The following are critical areas for continued research: determining the appropriate parameters for measuring environmental properties associated with this condition; understanding and being able to predict the fate and transport mechanisms of nutrients from land-based and riverine, atmospheric, and oceanic sources; identifying the factors influencing the susceptibility of various coastal ecosystems to nutrient over-enrichment; understanding the impacts of nutrient enrichment leading to such conditions as harmful algal blooms and their implication for all levels of the food web; and determining the effects of alterations to the nitrogen cycle on global climate change⁷.

Marine Protected Areas for Resource Management and Conservation

Current declines in commercial fisheries raise concerns that conventional management strategies are not working and have prompted managers to seek alternative strategies for achieving goals for the conservation of habitat, fisheries, or biological diversity. Marine protected areas, which may include no-take reserves, are a management tool that is being applied with greater frequency. Unfortunately, there is no scientific consensus on how these areas should be designed or their effectiveness evaluated over time.

Marine reserves present a unique opportunity for researchers to address important questions about marine populations and their habitat requirements. Research is needed to determine: the dispersal ranges of various life history stages of marine populations and the role of oceanography, physiology and behavior in dispersal; the impact of reserves on both exploited and unexploited species; and whether such areas serve as sources or sinks of larval recruits, including the minimum size necessary for efficacy in supporting sustainable, healthy populations and ecosystems⁸.

⁶ *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*, Ocean Studies Board and Water, Science and Technology Board. Commission on Geosciences, Environment, and Resources. National Academy Press, Washington, D.C., 2000.

⁷ Ibid.

⁸ *Marine Protected Areas: Tools for Sustaining Ocean Ecosystems*, Ocean Studies Board, National Academy Press, Washington, D.C. (prepublication copy).

It is imperative that the research and management communities work together to develop a science-based approach for designing, managing, and evaluating the effectiveness of marine reserves and in a broader geographic context than individual managed areas. In order to learn from both intentional and unintentional manipulations observing strategies need to be in place to monitor the positive and negative impacts of these large-scale experiments in ecological sustainability⁹.

Pilot programs to determine the most cost-effective strategies for mapping habitat, sampling marine biota, and monitoring physical, biological, and chemical parameters should be initiated as soon as possible in order to guide larger programs. Such programs can help to determine the appropriate measurable criteria for designing and evaluating the effectiveness of marine reserves in meeting various goals, including the sustainable management of marine resources.

Economic Sustainability

The oceans are important to the world's continued food security and contain unknown potential for new drugs and marine products. Two key research areas requiring enhanced attention are marine biotechnology and the decline in fisheries.

Marine Biotechnology

Exploratory research shows the great potential for exploiting the biochemical capabilities of marine organisms to provide new classes of pharmaceuticals, polymers, enzymes, analytical reagents, and food sources¹⁰. Overall, sales of biotechnology products reached \$13 billion in 1998, and could go as high as \$24 billion by 2005¹¹. Surprisingly, this boon in new products has been based primarily on terrestrial biota and has barely begun to tap the potential from the 80 percent of Earth's phyla that are found only in the sea. Japan has recognized the untapped market potential in marine biotechnology, and now outspends the U.S. by a factor of 10 in this area.

Marine biotechnology is also providing new tools and approaches for understanding biological diversity, the ecological relationships among marine organisms, and the state of marine populations. This is knowledge that is required to establish resource conservation strategies. Biotechnological approaches will aid in many other areas, such as monitoring and assessing the impact to organisms and ecosystems from toxic contaminants, detecting harmful algal blooms, and understanding the diseases of marine organisms. Also promising is the potential application of techniques for marine bioremediation in the aftermath of oil spills and for the restoration of damaged coral and reef habitats¹².

Realizing the potential of living resources in the U.S. EEZ for commercial and research applications will require a multidisciplinary, coordinated, and integrated approach, beginning with systematic exploration and taxonomic description of organisms ranging from microbes to megafauna¹³. With

⁹ *Understanding Marine Biodiversity*, Committee on Biological Diversity in Marine Systems, Ocean Studies Board, National Academy Press, Washington, D.C., 1995.

¹⁰ *The Sea's New Harvest, A Report on Marine Biotechnology in the National Sea Grant College Program*.

¹¹ COMPASS report of Marine Biotechnology

¹² *Opportunities for Environmental Applications of Marine Biotechnology*, Proceedings of the October 5-6, 1999 Workshop, Ocean Studies Board, Board on Biology, National Academy Press, 2000.

¹³ *From Monsoons to Microbes: Understanding the Ocean's Role in Human Health*, Committee on the Ocean's Role in Human Health, Ocean Studies Board, National Academy Press, Washington, D.C., 1999.

the coastal environment experiencing degradation, time is of the essence. Organisms with such potential may become extinct before anyone even knows that they exist. The COMPASS (Coordinated Marine Programs to Assess and Sustain the Sea) initiative has been proposed to the NSTC as a mechanism for federal investment, management, coordination, and promotion of marine biotechnology.¹⁴ Augmented support for basic research, as well as the development of new policies that encourage private sector investment in pre-commercial R&D, could greatly accelerate the discovery and development of new products from the sea.

Along with the identification of organisms with commercial potential should also come the obligation to protect such resources from over-exploitation. In most cases, taking from wild populations will not be a viable option to supply the development and marketing of marine bioproducts. Therefore, stakeholders must invest in research on environmentally sustainable use of marine resources, including options such as aquaculture, microbial fermentation, chemical synthesis, and transgenic production¹⁵.

Marine Fisheries

Many marine fisheries are in decline, and some fishing practices have had a detrimental effect on marine habitats and non-commercial species¹⁶. Several fisheries have been entirely closed in an attempt to restore them to a healthy state, and in many other cases increasing effort is required to achieve the same catch. The biomass of fish and invertebrates killed by ocean fishing every year (including catch, bycatch, and inadvertent mortality) probably exceeds 110 million metric tons per year. This number is likely in excess of the total productivity of ocean ecosystems¹⁷, which itself might be declining because of habitat destruction, pollution, and climate change. Long term, the latter effects may do more harm than the direct effects of fishing on targeted species¹⁸.

Clearly, the ocean's resources are not inexhaustible, and it is important to adopt an ecosystem approach to managing them¹⁹. Broad-based research is required to provide the fundamental understanding of ecosystem functioning necessary for informed policy decisions. Important areas of research include the need to: identify and characterize fisheries populations and to understand the ecological processes that limit these populations; determine the interaction between wild marine populations and aquaculture species; and understand how the collapse of one species or the entry of an invasive species may impact the food web and ecosystem health. More research is also needed on the biological effects of fishing, such as the alteration of gene pools and population structures as a consequence of fishing. Modeling approaches that incorporate environmental variability into fishery, multispecies, and trophic models need further development, testing, analysis, and calibration.

¹⁴ The report calls for a \$33 million dollar per year increase in funding for marine biotechnology research through the budgets of NSF, NOAA, and ONR.

¹⁵ *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*, President's Panel on Ocean Exploration, U.S. Department of Commerce, 2001.

¹⁶ *Sustaining Marine Fisheries*, Committee on Ecosystem Management for Sustainable Marine Fisheries, Ocean Studies Board, National Academies Press, Washington, D.C., 1999.

¹⁷ *Sustaining Marine Fisheries*, Committee on Ecosystem Management for Sustainable Marine Fisheries, Ocean Studies Board, National Academies Press, Washington, D.C., 1999.

¹⁸ *Ibid.*

¹⁹ *Ibid.*

As discussed previously, expansion of marine protected areas and thorough monitoring of their local and regional impact on fisheries would be important elements in fisheries research.

Cross-cutting Research Needs

Progress in addressing these categories of research providing a stronger scientific basis for supporting the conservation and sustainable use of marine resources within the U.S. EEZ would be accelerated by developing the capability to observe and monitor the changes in complex ecosystem dynamics in response to natural and human-induced perturbations. The most important first steps in establishing this monitoring capability are as follows:

1. Expand programs to characterize coastal ecosystems and monitor their response to intentional and unintentional perturbations using all relevant biological, chemical, and physical sensors (including those still in prototype stage). This expansion will require additional support for the development of suitable indicators of sustainability and stress. Monitoring programs in support of resource management would be most effective if they could be set up to include both protected and unprotected areas to determine the relative impacts of natural variability and human activities on ecosystem functioning and productivity in marine protected areas and reserves of various sizes²⁰.
2. Improve methods of data collection, management, and dissemination across government agencies and between public and private sectors²¹. More uniform data collection standards are needed so that data can be made more widely accessible and aggregated to reveal the bigger picture. Relevant scientific information also needs to be made available to decision-makers and other stakeholders in useful formats.
3. Invest in biological and chemical sensor research, to bring these systems to the same level of maturity and reliability as the current suite of physical sensors²². Some science questions and monitoring applications can only be addressed through the deployment of *in situ* analyzers²³.

²⁰ *Sustaining Marine Fisheries*, Committee on Ecosystem Management for Sustainable Marine Fisheries, Ocean Studies Board, National Academies Press, Washington, D.C., 1999.

²¹ *Clean Water Action Plan: Coastal Research and Monitoring Strategy*, The Coastal Research and Monitoring Strategy Workgroup, convened by EPA, NOAA, USDA, and USGS, August, 2000. *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*, President's Panel on Ocean Exploration, U.S. Department of Commerce, in press, 2000.

²² *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*, President's Panel on Ocean Exploration, U.S. Department of Commerce, in press, 2000.

²³ *Ocean Ecology: Understanding and Vision for Research*, Report of the OEUVRE Workshop, P. Jumars and M. Hay, Eds., National Science Foundation,

Promising prototypes exist, and their development should be brought to completion as soon as possible. Partnerships with commercial developers should be sought to increase availability and reduce production costs.

4. Support the development of joint coastal ocean circulation and ecosystem models. Even with better observing systems, data dissemination, and sensors as advocated above, it will still be impossible to observe everything of interest. Models constrained by observations are essential for ultimate understanding of these complex systems and prediction of their future evolution.

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APPENDIX 11

Ocean Research Advisory Panel Members

•Dr. Bruce Alberts: Dr. Bruce Alberts has chaired the National Research Council's Commission on Life Sciences and was principal author of *The Molecular Biology of the Cell*. Currently, he is the President of the National Academy of Sciences.

•Dr. Vera Alexander: Dr. Vera Alexander is currently a Commissioner of the United States Marine Mammal Commission, a Member, Science Advisory Board to NOAA, and U.S. Delegate to the North Pacific Marine Science Organization.

•Dr. Richard A. Anthes: Dr. Richard Anthes was the director of the National Center for Atmospheric Research (NCAR) Atmospheric Analysis and Prediction Division and in 1986 became director of NCAR. The University Corporation for Atmospheric Research (UCAR) selected him to become president in 1988, and he remains in that position today.

•Dr. Alfred Beeton: Dr. Alfred Beeton served as Acting Chief Scientist of the National Oceanic and Atmospheric Administration. Since retiring from his position at NOAA, Dr. Beeton is associated with the University of Michigan as an adjunct professor and is presently Chair of the Science Advisory Board of NOAA.

•Dr. Otis Brown: Dr. Otis Brown was Associate Dean for Research, Rosenstiel School of Marine and Atmospheric Science (RSMAS) in 1989; and Dean, RSMAS, since 1995.

•Mr. Lawrence Dickerson: Mr. Lawrence Dickerson is currently the President and Chief Operating Officer of Diamond Offshore Drilling, Inc. Prior to his promotion to this position in 1998, Mr. Dickerson held the position of Senior Vice President and Chief Financial Officer. He also serves as a director of the International Association of Drilling Contractors.

•Dr. Robert Frosch: Dr. Robert Frosch served as Administrator of the National Aeronautics and Space Administration (NASA) and retired from General Motors as Vice President in charge of the North American Operations R&D Center in 1993. Currently he is a Senior Research Fellow and Lecturer at the John F. Kennedy School of Government, Harvard University and a Senior Fellow at the National Academy of Engineering.

•Dr. Robert Gagosian: Dr. Robert Gagosian was appointed as Director of WHOI in 1994, after serving six years as Director of Research and two years as Senior Associate Director. He has served on a wide variety of visiting committees and advisory panels in the U.S. and internationally.

•Mr. David Keeley: Mr. David Keeley directed the Coastal Zone Management Program in Maine and has served as the Chairman of the Coastal States Organization. He currently chairs two local committees, volunteers with youth groups, and is vice-president of a non-profit foundation.

•Dr. John Knauss: Dr. John Knauss served as Under Secretary of Commerce for Oceans and Atmosphere/Administrator of the National Oceanic and Atmospheric Administration and was the

U.S. Commissioner to the International Whaling Commission from 1991 through 1993. He is past President of the American Geophysical Union.

- Dr. Marcia McNutt: Dr. Marcia McNutt is currently the President and Chief Executive Officer of the Monterey Bay Aquarium Research Institute. Prior to this appointment, Dr. McNutt spent 15 years at the Massachusetts Institute of Technology where she served as Director of the Joint Program in Oceanography and Applied Ocean Science and Engineering. She is also the current President of the American Geophysical Union.

- Mr. Joel Reynolds: Mr. Joel Reynolds has specialized in complex law reform litigation and has argued cases on behalf of environmental and community organizations at all levels of the federal courts, including the U.S. Supreme Court. Mr. Reynolds heads the Natural Resources Defense Council Coastal Ecosystem and Marine Mammal Protection Project.

- Dr. Denise Stephenson-Hawk: Dr. Denise Stephenson-Hawk has been appointed to national committees such as NSF's Geosciences Advisory Committee, NASA's Earth Systems Science Applications Advisory Committee, and NOAA's Science Advisory Board. She has worked with educators at the K-12 level, serving as the co-chair for the statewide (Georgia) Workshop for K-12 Teachers of Mathematics and Science in 1998. She served as Provost of Spelman College and is currently the Chair of the Stephenson Group in Atlanta, GA.

- Dr. Patrick Sullivan: Dr. Patrick Sullivan has served as the Vice-Chairperson of Hawaii's High Technology Development Corporation (HTDC). Dr. Sullivan founded Oceanit Laboratories, Inc. (Oceanit) in 1985, and is currently president.

APPENDIX 12

FY 1998 – 2000 National Oceanographic Partnership Program Project Reports

A. OPERATIONAL/ROUTINE OBSERVATIONS

TITLE: Commercial Fishing Vessels as Platforms for Coastal Ocean Research, Monitoring, and Management

Ann Bucklin, New Hampshire Sea Grant Program

142 Morse Hall, University of New Hampshire, Durham, NH 03824

phone (603) 862-0122 fax (603) 862-0243 email acb@christa.unh.edu

Project Partners:

Peter H. Wiebe, Woods Hole Oceanographic Institution, Woods Hole, MA 02543

phone (508) 289-2313 fax (508) 457-2169 email pwiebe@whoi.edu

Chrys Chrysostomidis, MIT Sea Grant Program, Massachusetts Institute of Technology

Cambridge, MA 02139 phone (617) 253-7131 fax (617) 258_5730 email

chrys@deslab.mit.edu

W. Gary Williams, Clearwater Instrumentation, Inc., 304 Pleasant Street, Watertown, MA

02172 phone (617) 924-2708 fax (617) 924-2724 email wgwill@world.std.com

Craig A. Pendleton, Portland Fish Exchange, 31 Seaside Avenue, Saco, ME 04072

phone (207) 284-5374 fax (207) 284-1355 email nama@lamere.net

Project Web Address: <http://www.FleetLink.org>

Award Made: FY 1998

LONG-TERM GOALS

This project, designated “FleetLink”, will develop partnerships between commercial fishermen and researchers, educators, and coastal managers for the collection, real-time telemetry, analysis, assimilation, distribution, and use of environmental and fisheries data from coastal regions off the northeastern US. The FleetLink partners will equip participating commercial fishing vessels with integrated sensor systems (including navigational, hydrographic, and meteorological components), and link them via satellite to land-based centers for collection, management, analysis, and assimilation of data. We are working toward a goal of 100 or more fully-instrumented fishing vessels which may provide enhanced oceanographic and meteorological data collection capacity for coastal and offshore areas throughout the NW Atlantic.

OBJECTIVES

- To develop a collaboration between commercial fishermen, private marine industries, oceanographers, and coastal resource managers for the collection, real-time telemetry, analysis, assimilation, distribution, and use of environmental and fisheries data from coastal regions off the northeastern US.

- To design and produce an integrated sensor system (including navigational, hydrographic, and meteorological components) for use onboard commercial fishing vessels; assemble, integrate, and test prototype versions of the system on a small number of vessels; establish land-based centers for collection, analysis and assimilation of data.
- To develop strategies for incorporation of the environmental and fisheries data into the missions of the targeted end users, including: NMFS assessments, NOAA and Navy coastal modeling and prediction efforts, marketing strategies for commercial products, and oceanographic research programs.

WORK COMPLETED

Partnership Building: FleetLink is a partnership between researchers, engineers, entrepreneurs, and commercial fishermen. Leadership of FleetLink by New Hampshire Sea Grant ensures the extension of the results to a diverse group of end users. Sea Grant Extension staff at UNH and MIT are responsible for facilitating communication and coordination between the research and fishing communities. Fishermen's organizations, particularly the Northwest Atlantic Marine Alliance (NAMA), help build fishermen's interest in FleetLink and identify vessels for prototype demonstration. The FleetLink partnership has become an acknowledged player in the tangled world of cooperative (i.e., commercial fishermen and researchers) research programs in the Northeast US. The FleetLink concept has attracted interest from the National Weather Service, National Marine Fisheries Service, the Naval Oceanography Office, and state and quasi-governmental organizations (including the Massachusetts Marine Fisheries Recovery Commission). We have built a working relationship within this nexus of organizations, from which we expect to identify partners, funding sources, and customers for our data.

FleetLink System Design and Operation: Three prototype FleetLink sensor systems have been produced and installed on commercial fishing vessels. Field demonstrations of the systems' capabilities began in November and will continue during routine fishing operations and planned experiments from January to July, 2001.

The FleetLink system consists of an on-board Pentium II based computer with LCD medium resolution screen; serial interfaces connect to oceanographic (sea surface temperature and temperature/pressure) and meteorological (wind speed and direction; air temperature, relative humidity, and pressure) sensors, an InmarSat satellite C communication Transmit/Receive unit, and a GPS receiver. Data from the FleetLink Sensor System are acquired by a PC-based system mounted in the vessel's pilothouse. MIT developed this system using commercially-available hardware, standard software modules, and a custom-developed software application referred to as "WheelHouse". The WheelHouse software application incorporates multitasking using several software packages, including Athena (a shipboard sensor interface program developed at Woods Hole Oceanographic Institution for its research vessels). Data on fishing activity and relevant observations are entered by the captain using custom graphic user interfaces (GUIs) that accept touch screen, mouse, and keyboard entries. Control of WheelHouse functions, including GUIs and data displays, is through pull_down menus. Specific GUIs facilitate the gathering of vessel, trip, tow, and catch data, as well as comments by the captain on any aspect of the boat or its operation. The display of sensor data is facilitated using a strip chart feature linked to each sensor's data stream. The receiving system is a LINUX-based PC located at WHOI which receives, serves, and

stores the environmental and fisheries data. With the exception of the fishery catch data (which are confidential), the processed data are available to end users.

Prototype Demonstration: FleetLink sensor systems have been installed on three commercial fishing vessels: F/V Susan & Caitlyn (Portland, ME), F/V Glenna & Jacob (Fall River, MA), and F/V Adventurer (Portland, ME). Operation of the prototype FleetLink systems is being demonstrated during January to March, 2001, while all three vessels are engaged in their usual fishing operations. We expect that the F/V Susan & Caitlyn and F/V Glenna & Jacob will be shrimping in the Gulf of Maine (working out of Portland, ME) during much of this period, while the F/V Adventurer will be trawling farther offshore.

Outreach: We have tapped a genuine interest and need in the fishing community for better ocean and meteorological data, for near-real-time and open access to fisheries catch data, for confidential communication between vessels at sea and their home ports. We have identified fishermen in Maine, New Hampshire, and Massachusetts who are committed to ocean monitoring and research.

IMPACT

The FleetLink partnership provides a mechanism for bringing together those involved in the fishing industry, the oceanographic community, and the federal agencies responsible for resource assessment and management. Successful completion will entail broad cooperation among coastal resource managers in programs and agencies across the Departments of Commerce, Defense, and Transportation. This effort will also result in better, largely automatic, and near real-time method of reporting offshore meteorological and sea conditions for use by a wide variety of communities, and for reporting catch records to local cooperatives. There is a pressing need for better environmental data from coastal and offshore marine waters in order to effectively monitor the health of the ecosystem, and to more effectively manage marine resources.

Publications resulting from this award:

A. Bucklin, C. Goudey, K. Ekstrom, P.H. Wiebe, R. Groman, W.G. Williams, R. Barnaby, C.A. Pendleton (2001) FleetLink: Collection and Telemetry of Ocean and Weather Data from Commercial Fishing Vessels. Sea Technology (manuscript in review)

TITLE: An Integrated System for Real-Time CTD Profiling Float Data on Basin Scales Dean Roemmich, Scripps Institution of Oceanography

Project Partners:

Russ Davis, Scripps Institution of Oceanography

W. Brechner Owens, Woods Hole Oceanographic Institution

Raymond Schmitt, Woods Hole Oceanographic Institution

Pierre Tillier, Seascan Inc

Stephen Riser, University of Washington

Douglas Webb, Webb Research Corporation

Robert Molinari, NOAA Atlantic Oceanographic and Meteorological Laboratory

Gregory Johnson, NOAA Pacific Marine Environmental Laboratory

Award Made: FY 1999

LONG-TERM GOALS

This award initiates the U.S. component of the international Argo Project. By 2005, Argo will deploy a global array of 3000 profiling CTD floats (Argo Science Team, 1998, Roemmich and Owens, 2000, see also <http://www.argo.ucsd.edu>), plus a data system that will make all Argo data available to both operational users of real-time data and to scientific users of a high-quality data stream. The Argo array will provide unprecedented real-time views of the evolving physical state of the ocean. It will reveal the physical processes that balance the large-scale heat and freshwater budgets of the ocean and will provide a crucial dataset for initialization and assimilation in seasonal-to-decadal forecast models. Argo is a major initiative in oceanography, merging research and operational objectives to provide a uniquely valuable global dataset for climate science and other applications.

OBJECTIVES

Phase I of U.S. Argo (9/99 – 9/02) provides 55 profiling floats in the tropical Pacific and Atlantic Oceans. These floats will demonstrate technological capabilities for fabrication and deployment of arrays in remote ocean locations. Recent technology developments will also be implemented during this deployment. New generation salinity sensors will be utilized for improved data quality. Capability for float deployments from fast ships and aircraft will be further developed to ensure that the Argo array can be successfully installed globally without dependency on research vessels.

Development of the Argo Data System is part of Phase I, on a collaborative basis with international partners. It will provide a real-time data set including all Argo profiles with uniform quality control procedures, and a scientifically quality controlled dataset that includes both P.I. examination of individual profiles and comparisons against neighboring profiles and climatological data. Phase II of U.S. Argo (7/00 – 6/01) provides an additional 132 profiling floats in the Atlantic plus the tropical Pacific and Indian Oceans. The objective of Phase 2 is to demonstrate the capability for manufacture and deployment of large float arrays and for handling the resulting data stream.

ACTIVITIES/ACCOMPLISHMENTS

A meeting of PIs, together with representatives of interested agencies and of the Argo user community (NODC, NCEP, FNMOC, U.S. GODAE, U.S. CLIVAR) was held in Seattle in August 2000. Priorities were set for deployment of Phase II and remaining Phase I floats, based on establishing substantial arrays in regions having high scientific interest and high impact on seasonal-to-interannual prediction, and to complement international partners in building the global Argo array. Floats were targeted for the warm pool region of the western Pacific (68 floats) and eastern Indian Oceans (15 floats), with additional allocations for the Atlantic (76 floats) and the northeastern Pacific (16 floats). These, together with 12 floats already deployed in the southeastern tropical Pacific, form the total of Phase I and II floats.

Because of the high priority of the western tropical Pacific and the fact that most of the waters there are within the 200-mile extended economic zones of Pacific Island nations, an effort is being made to gain concurrence for Argo deployments from Pacific Island Forum nations. A request has been forwarded and we are awaiting confirmation.

Deployments have begun in the Pacific (11 SIO plus 8 UW/Webb floats) and Atlantic (16 UW/Webb floats), using both Volunteer Observing Ships and research vessels. The next deployment will

consist of 8 WHOI floats in the Atlantic in January 2001. Of the 35 floats deployed to date, all are presently reporting good T/S profile data.

All data have been forwarded to the U.S. Argo Data Center at NOAA/AOML in Miami. The real-time data stream is running at AOML and all Argo profiles are being transmitted via the Global Telecommunications System (GTS) for worldwide dissemination. The real-time quality control software will shortly be tested and implemented at NCEP for 24/7 operation. A system has been developed for delayed mode recalibration of salinity sensors and is presently being tested. A meeting of international Argo data managers was convened at IFREMER, Brest, France in October 2000 by R. Molinari and S. Pouliquen. All participants agreed to standardize methods and initial protocols were established. In addition it was decided to have two Argo Data Centers from which all profiles will be available. IFREMER has agreed to be one and FNMOC, Monterey has been contacted to serve as the other.

ANTICIPATED IMPACTS

Demonstration of the ability to deploy and maintain large-scale profiling float arrays in Phase I and II of U.S. Argo, as well as the public distribution of real-time and delayed mode datasets will confirm the practicality of the program. Utilization of the Argo profiles in regional-to-global data assimilation systems as well as in other real-time applications and scientific investigations will confirm its broad value to the user community.

REFERENCES

- Argo Science Team, 1998. On the design and implementation of Argo: A global array of profiling floats. International CLIVAR Project Office Report No. 21.
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B. RESEARCH “OBSERVATORIES”

TITLE: Front Resolving Observational Network with Telemetry (FRONT) Philip Bogden, University of Connecticut

Project Partners and Responsibilities:

P. Bogden - Data assimilation/modeling, University of Connecticut (UConn)
D. Codiga - Shelf dynamics, UConn
J. O'Donnell - Front dynamics & observations, UConn
I. Babb - Coastal Ecology/ROV, UConn
P. Cornillon - Remote sensing, University of Rhode Island (URI)
D. Hebert - Turbulence and mixing, URI
P. Stegmann - Remote sensing and ocean color, URI
S. Legg - Ocean modeling, Woods Hole Oceanographic Institution (WHOI)
S. Gallagher - Zooplankton ecology/measurement, WHOI
H. Sosik - Phytoplankton ecology, WHOI
J. Marshall - Ocean modeling, Massachusetts Institute of Technology (MIT)
M. Follows - Biochemical ocean modeling, MIT
E. Levine - Turbulence and mixing, AUV, Navy Undersea Warfare Center
A. Allen - Drifters in Search and Rescue, United States Coast Guard
D. Porta - Acoustic modems, Benthos, Inc.
J. Rice - Telesonar communications, SSC-SD
B. Lipa - HF radar for surface currents, Codar Ocean Sensors, Ltd.
D. Barrick - HF radar for surface currents, Codar Ocean Sensors, Ltd.

Award Made: FY 1999

We are developing an observation and prediction system for a dynamically complex region of the coastal ocean. The easily deployed, cost-effective ocean-observation system provides a diverse range of real-time physical and biological measurements. These measurements are being integrated into “data-assimilative” computer models of physical and biological processes in the coastal ocean. The data-assimilative approach to ocean observation mitigates the impact of sampling inadequacies and allows ocean forecasting.

In situ components of the system are disturbance-resistant and inexpensive to replace. Data telemetry and instrument control utilize an underwater communication network. The wireless network features multiple acoustic modems connected in a topology that can tolerate failure or loss of individual elements. Scientific needs for reliable wireless underwater communication are linking strongly to U.S. Navy development of acoustic communications and surveillance capabilities. The demonstration site lies on the continental shelf at the eastern end of Long Island Sound. This region exhibits strong tides with energetic wind- and buoyancy-forced motions. The resulting flow field is complex and exhibits a variety of scientifically interesting front-like features. These ocean fronts attract considerable commercial fishing activity which, in turn, presents a challenge to the observation system. The performance of the integrated system will be evaluated with ship surveys designed to resolve all scales of variability.

PROGRESS TO DATE

Three field programs have exercised the underwater data telemetry system and provided tests of the individual components of the *in situ* measurement program. The first test occurred during November of 1999, with supplementary testing in 2000. Activities in 2001 and 2002 will test the integrated system.

In the 1999 sea tests, acoustic communications rarely exceeded one kilometer and severe degradation of transmission quality occurred during strong wind events. The 2000 sea tests exhibited substantially improved performance, with more than triple the range of the 1999 tests. Large-scale surveys showed that highly variable environmental conditions may be partly responsible for the improved communications in 2000. However, much of the improvement stems from technological advances in the intervening months by the NOPP partners at SSC-SD and Benthos Inc.

WHOI scientists under the guidance of Dr. Scott Gallager have successfully tested their Autonomous Vertically Profiling Plankton Observatory (AVPPO). This bottom-mounted instrument platform measures a suite of variables, including video images of microscopic organisms. The images are processed by onboard computers which determine zooplankton-species composition, and results of the analyses are transmitted to shore in real time. The field program has included successful tests of other systems, including a novel technology for measuring turbulence from an Autonomous Underwater Vehicles (AUVs) by Dr. Ed Levine of NUWC.

Preliminary computer model results have produced some surprising results. Computer simulations of a spreading dye patch reproduce many of the front-like features seen in satellite temperature and color data, and CODAR current measurements (which have been operating since the spring of 2000). Such features are generally associated with complex ocean-density variations and buoyancy effects. However, computer simulations show that the effects might be explained with a surprisingly simple tidal model. This preliminary result is being investigated with data comparisons. The ultimate tests will occur during the 2001 and 2002 implementations of the integrated observation system.

TITLE: Design Study for NEPTUNE: A Fiber-Optic Telescope to Inner Space **John R. Delaney, School of Oceanography, University of Washington**

Project Partners:

Funded through this NEPTUNE NOPP grant:

- University of Washington's (UW) School of Oceanography and Applied Physics Laboratory
- Woods Hole Oceanographic Institution (WHOI)

Funded through other NEPTUNE NOPP grants:

- NOAA's Pacific Marine Environmental Laboratory (PMEL)
- NASA's Jet Propulsion Laboratory (JPL), California Institute of Technology

Other NEPTUNE Partners:

- Monterey Bay Aquarium Research Institute (MBARI)
- Institute for Pacific Ocean Science and Technology (IPOST) (Canada)

Award Made: FY 1998

PROJECT OBJECTIVES, ACTIVITIES, ACCOMPLISHMENTS, AND RESULTS:

The NEPTUNE project will lay 3,000 kilometers of fiber-optic/power cable to convert the Juan de Fuca tectonic plate and the overlying ocean to a suite of extended natural laboratories spaced about 100 kilometers apart. This network of undersea laboratories will enable unprecedented real-time observations and experiments with the dynamic earth-ocean system at the scale of a tectonic plate. The Juan de Fuca plate was chosen for its representative spectrum of globally occurring natural processes and because it is in an ideal location in the northeast Pacific Ocean off the coasts of British Columbia, Washington, and Oregon. NEPTUNE is one component of the Integrated Ocean Observing System initiative put forth by NOPP and recently endorsed by the National Research Council in the report entitled *Illuminating the Hidden Planet*.

One of NEPTUNE's most important early efforts was to establish that there are powerful intellectual and societal reasons for implementing the project and that it is technically and financially feasible. Our results have been published in the June 2000 NEPTUNE Feasibility Study, which was undertaken with support from NOPP and the four NEPTUNE Phase 1 partners: WHOI, JPL, PMEL, and UW. Scientists and engineers from the partners as well as many other institutions contributed their highest efforts and thought to this 105-page Study, which is posted on the NEPTUNE web site at www.neptune.washington.edu.

Since completion of the Feasibility Study, we have added two new partners to the project: Canada's Institute for Pacific Ocean Science and Technology and the Monterey Bay Aquarium Research Institute. These two institutions will each contribute significant strength to the NEPTUNE effort.

The NEPTUNE Canada (www.neptunecanada.com/) effort is led by John Madden, vice chair of IPOST, which is a non-profit organization made up of members from academe, industry, and government. In March 2000, IPOST hosted a major national meeting in Victoria. Nearly 65 people from across Canada participated, including the Honorable David Anderson, Canada's Minister of the Environment. The NEPTUNE Canada Science Report, published as a result of this meeting, is available at www.neptunecanada.com/docs/NEPTUNECanadaScienceReportGraphics.PDF. Just recently, the Canadian Feasibility Study (*NEPTUNE Canada: Feasibility of Participation in the NEPTUNE Undersea Observatory Network*), was released in conjunction with a press conference held on November 16, 2000 in Victoria, British Columbia. The Canadians are intending to raise about one third of the funding for NEPTUNE construction and are planning a shore landing and NEPTUNE visitors' center in Victoria. The Monterey Bay Aquarium Research Institute, under the direction of Marcia McNutt, has received funding approval from the Packard Foundation Board to develop a NEPTUNE testbed in Monterey Bay. There will be a shallow and a deep node, both designed to be identical to a NEPTUNE cable node. Total funding represents several million dollars over five years.

NEPTUNE's Phase 2, Development, was formally launched at a meeting held in Canada in late September 2000. Representatives from all partners attended. NEPTUNE's organizational structure was formalized into three major teams: the Science Implementation Team, the Infrastructure Implementation Team, and the Education and Outreach Implementation Team. These teams are presided over by an Executive Team made up of one member from each of the Phase 2 partners (with two members from Canada) plus the chair of each of the three implementation teams.

Executive Team members are Patricia Beauchamp from JPL, Alan Chave from Woods Hole, John Madden and Verena Tunnicliffe from Canada, and Marcia McNutt from MBARI. John Delaney of the UW is the Executive Team's chair. Another key step for the project was when Patricia Beauchamp agreed to serve as Program Manager for the technical side of NEPTUNE. Pat is Director for the Center for In Situ Exploration and Sample Return at JPL and has twelve years of experience managing large programs that come in on time and under budget.

The Canadian National Research Council's Space Observatory Group in Canada has agreed to lead NEPTUNE's data management and archiving effort and is preparing a proposal for a major workshop to launch this component of NEPTUNE. Located in Victoria, this group is responsible for Hubble Space Telescope data in Canada and is a key member of the Gemini project. The NEPTUNE education and outreach effort took a significant step forward with a November 2000 workshop. Sixty-five participants, including science teachers, curricula developers, educators at science centers and aquariums, and scientists spent two days brainstorming ideas on the best use of NEPTUNE's real-time data capabilities in formal and informal science education. A report from this meeting is posted at www.neptune.washington.edu.

The UW has contributed \$1 million to NEPTUNE activities and operations for the 1999-2002 period. In fall 2000, WHOI received funding from the National Science Foundation's Major Research Initiative program for Alan Chave's work on NEPTUNE's communications system. In November 2000, NEPTUNE was invited to submit a Phase 1, preliminary proposal letter to the Keck Foundation in Los Angeles. The request for \$5 million is for funding of science related to NEPTUNE. Notification regarding the success of this Phase 1 letter will be received by mid February 2001. If successful, we will be invited to submit a full proposal in March 2001.

TITLE: Renewal Proposal Multi-Scale Model-Driven Sampling with Autonomous Systems at a National Littoral Laboratory

Scott M. Glenn and Oscar M.E. Schofield, Rutgers University, Institute of Marine and Coastal Sciences

Project Participants:

S. Glenn, O. Schofield, D. Haidvogel, F. Grassle, E. Levine, D. Barrick, B. Lipa, and M. Moline

Partners Institutions:

Rutgers University

Naval Undersea Research Center

CODAR Ocean Sensors

California Polytechnic State University

Award Made: FY 1997; Renewed: FY 2000

LONG-TERM GOALS

The long-term goal of our coordinated NOPP and ONR (COMOP/HyCODE) research efforts is the development and validation of a relocatable coastal ocean forecasting system. The system consists of a coupled atmospheric-hydrodynamic-biological data-assimilative numerical model and a multi-platform real-time adaptive sampling network. The system will be demonstrated and validated

during a series of four annual Coastal Predictive Skill Experiments (CPSEs) conducted during July of 1998-2001.

OBJECTIVES

There are four primary objectives to this renewal:

- 1) Facilitate transition and integration of NOPP-sponsored observation systems developed during the 1998 and 1999 CPSEs with the NURP-sponsored long-term observation network for use during the 2001 and 2002 ONR-sponsored CPSEs.
- 2) Update real-time observational products produced in previous years based on new algorithms developed in later years.
- 3) Update real-time model products using improved versions of the atmospheric and ocean models used in later years.
- 4) Document the experiments in a series of peer reviewed journal articles.

ACTIVITIES/ACCOMPLISHMENTS

Most NOPP-sponsored activities focussed on preparation for and completion of the 2000 CPSE. CODAR surface current fields were improved by using measured beam-patterns for the receiver antenna. The improved quality of the fields allowed us to identify convergence and divergence zones in real-time for adaptive sampling by the CalPoly biological survey vessel.

An ensemble of ocean forecast model runs was generated during each of seven forecast cycles during the 2000 CPSE. The ensemble included sensitivities to initial conditions, atmospheric forcing and turbulent closure schemes. Validation metrics are being developed to assess forecast quality and model improvements. Initial indications are that the forecasts within the ensemble are most sensitive to the choice of atmospheric model. This sensitivity has prompted us to more closely examine the quality of both the RAMS and COAMPS atmospheric forecasts before proceeding with a hindcast of previous years. The improved turbulent closures will be used for future comparisons with the NUWC REMUS turbulence data.

Cal-Poly has begun reanalyzing phytoplankton samples collected during the 1998 and 1997 field seasons. Measurements for phytoplankton accessory pigments are being made using high pressure liquid chromatography.

The NOPP/ONR field data is be used to calibrate the new generation of ocean color algorithms which provide measurements for the inherent optical properties. As part of that effort, Rutgers, in collaboration with Sequoia scientific, has been assessing the impact of assuming fixed light scattering phase functions. This was initiated in part to improve optical closure for the waters which are dominated by inorganic particles. These algorithms appear to be robust for waters dominated by organic particles.

Dr. John Klinck, editor, JGR Oceans, and Dr. Roni Avissar, editor, JGR Atmospheres, have been contacted concerning a joint special section of JGR focused on LEO research activities. Potential paper titles have been solicited from the community. The titles are being compiled in a proposal in preparation for submission to JGR.

ANTICIPATED RESULTS/IMPACTS

The LEO-15 observatory serves as a template for proposed regional coastal ocean observatories now under construction. The significant role of real-time CODAR surface currents for Rapid

Environmental Assessment applications was established. This led to the funding of several new long-range CODAR sites and the successful implementation of the bistatic CODAR concept as one key component of a regional observatory. Glider AUVs successfully tested at LEO and on the West Coast are likely to become a second key component. Free real-time satellite ocean color data available from the international constellation is expected to be the third key component.

Real-time tests of two atmospheric models (RAMS and COAMPS) used to drive the ROMS ocean model have led to efforts to develop two-way coupled versions with both atmospheric models. Development of a series of advanced data-assimilation schemes for the ocean model with numerous academic partners has been initiated with ONR funding.

Web access to the LEO datasets currently averages about 50,000 hits per day during the summer, demonstrating its usefulness for public outreach and educational programs. Discussions with the Coast Guard to use the regional observation and modeling system to improve search and rescue operations are rapidly accelerating.

TITLE: Ocean Acoustic Observatory Federation (OAOF)
John A. Orcutt, Scripps Institution of Oceanography, La Jolla, CA

Project Partners:

Naval Postgraduate School
NOAA Pacific Marine Environmental Laboratory
Scripps Institution of Oceanography
University of Washington Applied Physics Laboratory

The OAOF has made great progress this year in understanding the excitation of acoustic waves in the ocean by earthquakes and volcanoes. This is particularly important given the minimal attenuation of low frequency acoustics once introduced into the ubiquitous ocean sound channel. A small volcano, marine mammal, or earthquake in a remote part of the Pacific basin can be readily detected and identified by hydrophone arrays in another part of the basin. The active and retired SOSUS stations remain important tools for these studies and provide a strong rationale for new hydrophones and arrays for solely scientific studies.

The research team (Drs. Robert Dziak and Chris Fox) at NOAA/PMEL has detected harmonic tremor associated with volcanic activity in the western Aleutians on several (21) occasions between April 1998 and December 1999. While the detections of volcanic activity within the basin have been reported since the 1950's using hydroacoustic methods, harmonic tremor has been largely observed on land and not reported in the oceans. The PMEL has now documented harmonic tremor from the Volcano Island arc south of Japan, an area that commonly experiences volcanic eruptions. The signals are characterized by a high-amplitude fundamental centered at 10 Hz with three harmonics at 20, 30, and 40 Hz, and are very similar to harmonic tremor signals observed using traditional seismic methods at active subaerial volcanoes throughout the world. The signals were more recently detected in June, September, and October 2000 after a 6-month hiatus. During periods of peak energy radiation, the tremor could be clearly detected on hydrophones in the western Aleutians, Hawaii, the west coast of the US, the eastern equatorial Pacific and were detected by the French Polynesian seismic network at a distance of 14,000 km.

The OAOF research teams at Scripps (deGroot-Hedlin and Orcutt) and UW/APL (Park, Soupkup, and Odom) have published extensively on the mechanisms for coupling earthquake and volcano energy into the ocean sound channel. The excitation mechanism of oceanic T-phases has been a puzzle for almost fifty years, with refraction from a sloping seafloor and seafloor scattering as two of the most widely invoked mechanisms. By representing the propagation of the acoustic field as a sum of normal modes (deGroot-Hedlin and Orcutt) and relying upon a similar representation of the source field (Park, Soupkup, and Odom), it is clear that the two views of excitation are closely related). Scattering from a rough seafloor converts energy from the directly excited ocean crustal/water column modes to the propagating acoustic modes comprising the oceanic T-phase. The excitation and propagation problems have been largely solved and the results have important implications for monitoring submarine earthquakes and volcanoes and the monitoring of chemical and nuclear explosions in the oceanic environment.

One of the most exciting recent results from OAOF research is the realization that recorded signals depend strongly on the earthquake source mechanism itself. In the past, it was felt that the source type was largely unimportant in the excitation of the T-phase or water-borne signal from such events. However at PMEL, Robert Dziak has shown that T-phase energy is clearly related to the earthquake source type. He has studied 170 earthquakes with magnitudes between 3.7 and 6.9 in the northeast Pacific, which were recorded by both land-based seismic networks and the SOSUS system. The acoustic energy release of each earthquake was estimated from the T-waves recorded by the hydrophone arrays; that is, the source level at the seafloor was estimated through corrections for propagation and receiver sensitivity. He found that the T-phase energy was lower for normal fault earthquakes (e.g. vertical offset events at volcanic centers) than for strike-slip events (e.g. the San Andreas). A detailed comparison suggests an apparent continuous decrease of acoustic energy of the earthquake as the component of dip-slip motion increases. These observations indicate that fault parameter information is contained within the T-wave signal packet, even after conversion of seismic energy to acoustic energy occurs across the seafloor-ocean interface. Furthermore, it was found that the smallest earthquake used (3.8) was associated with a seafloor source level of 205.3 dB while the largest (6.9) had a source level of 229.2 dB. These are probably the largest, natural source levels in the oceans.

The research team at UW/APL (Park, Soukup, and Odom) has provided a theoretical rationale for the earthquake observations cited above. The earthquake source excites crustal/ocean modes differently as the mechanism changes. They predict, as observed, that the excitation of modal amplitudes by strike-slip faults are much larger than for the normal faults.

The OAOF team at NPS and Scripps (Hua, Collins, Miller, Worcester, and Chiu) has continued the operation and analysis of data from the California Current observatory between an acoustic source on Hoke Seamount and the SOSUS array at Point Sur. They have found that although the path is 624 km in length over complex tomography, the received signal is stable and well-modeled using ray theory. While the arrivals are groups of unresolved, individual rays, a waveform inversion scheme can be successfully used for tomographic inversion. They have found, in recordings from July 1999 to February 2000, that the upper ocean isotherms were more tilted toward the coast and that the California Current Front was weaker than the “average year.” The observatory can clearly be used to monitor changes in the seasonal cycles as well as interannual variability in the current.

There is a cable fault in the SOSUS cable at Pt. Sur about 0.8 nmi from the terminal. This fault was discovered in 1985 and has progressed now to a 90% failure level. It will be completely severed some time in 2001. ONR has provided funding for cable repair and this work will be undertaken in September 2001. Additional cable will be patched into the existing cable to avoid the bare rock portion of the installation, which caused the original problem over decades of exposure.

TITLE: The Innovative Coastal-Ocean Observing Network (ICON)

Jeffrey D. Paduan, Naval Postgraduate School

Dept. of Oceanography, Code OC/Pd, Naval Postgraduate School, Monterey, CA 93943

phone: (831) 656-3350; paduan@oc.nps.navy.mil

ICON Partner Institutions and Primary Responsibilities:

Naval Postgraduate School - Moored Obs, HF Radar Obs, Acoustic Tomography

University of Michigan - HF Radar Obs. and Construction

California State University Monterey Bay - HF Radar Obs.

University of Southern Mississippi - Circulation Modeling and Data Assimilation

Naval Research Laboratory - Bio-Phys. Modeling

HOBILabs, Watsonville, CA - Moored Optics Sensors, Bio-Phys. Modeling

Monterey Bay Aquarium Research Institute - Mooring Deployment, Bio-Phys. Modeling

Codar Ocean Sensors, Ltd., Los Altos, CA - HF Radar maintenance and algorithm development

Project Web Address: <http://www.oc.nps.navy.mil/~icon>

Award Made: FY 1998

A partnership between government, academic, and industrial scientists working around Monterey Bay has been created to show how a diverse suite of ocean instrumentation can be integrated into a real-time ocean observation network. The program, named an Innovative Coastal-Ocean Observing Network (ICON), was initiated in August 1998 and continued under NOPP funding through December 2000. The partnering institutions and their primary responsibilities are shown in Table 1. The specific objectives of the project are to evaluate the several real-time observing systems as components of future coastal monitoring networks as well as sources for data-assimilating numerical models.

APPROACH

The approach taken in this project is to build on existing partnerships and observing systems around the Monterey Bay region by providing coordination, additional instrumentation, and a focus on evaluating the impact of the various measurements on the validation and forcing of a coastal circulation model. The major components of the observing network include 1) surface current maps from shore-based high frequency (HF) radar installations, 2) subsurface currents, temperature, salinity, and bio-optical properties plus surface meteorological properties from several deep-ocean moorings, 3) sea surface temperature and color from satellites, and 4) along-track temperature and temperature variances from two acoustic tomography slices through the region. These data sets each involve real-time data telemetry. They are also being used as either validation or assimilation sources for a nested, primitive equation numerical model designed to track the evolution of mesoscale filaments and eddies.

WORK COMPLETED

Additional HF radar stations were deployed south of Monterey Bay, moored observations were retrieved from five offshore sites, and acoustic travel times were collected from one along-shore and one cross-shore tomography section. Shorter-term deployments of the NPS FLUX buoy and of a bottom-mounted ADCP with acoustic telemetry were made in August 2000 in conjunction with a Navy-sponsored field campaign. Also during that campaign, thirteen separate synoptic surveys of sea surface temperature, air temperature, and winds were made from an instrumented aircraft. The numerical model was spun up from 1995 using NOGAPS wind forcing and lateral boundary conditions from the NRL Pacific West Coast (PWC) model, which itself is nested within the NRL $\frac{1}{4}$ degree, global layered model. Multiple runs of the ICON model for 1999 have been conducted to evaluate the role of wind forcing (100 km NOGAPS vs. 9 km COAMPS), the effectiveness of various data assimilation techniques, and the sensitivity to surface heat fluxes. In addition, a triply nested model grid was generated for the Monterey Bay region to be used to investigate specific case studies of upwelling fronts and filaments sampled during the August 2000 field campaign.

RESULTS

The model performance is quite good at seasonal time scales, which is a validation of the one-way nesting because these variations are successfully tracked by the PWC regional-scale model. At higher frequencies, the model does not reproduce the observed level of variability. Other problems are visible near the surface where the model mixed layers are too deep in summer and too shallow in winter, which is certainly a reflection of the lack of heat flux forcing. This problem is mitigated to a significant degree when higher resolution COAMPS winds are used along with COAMPS model heat fluxes.

Assimilation of velocity data from low-pass-filtered HF radar data has been tested using the machinery of Physical-Space Statistical Analysis System (PSAS) and spatial error covariances based on seasonal statistics from the HF radar data (see Shulman et al., 2000ab). Despite the surface-only nature of the assimilation (no vertical projection was made during the assimilation), divergences in the correction fields imposed by the observed velocity patterns quickly penetrate to about 100 m within the main thermocline. In addition, the limited-area corrections can be seen to have an effect outside the spatial range of the actual data.

IMPACT/APPLICATIONS

The likely impacts of this project include improved real-time communication, processing, and display of coastal ocean data along with improved algorithms for assimilating that data into numerical models.

PUBLICATIONS

Shulman, I., C.-R. Wu, J.K. Lewis, J.D. Paduan, L.K. Rosenfeld, S.R. Ramp, M.S. Cook, J.C. Kindle, and D.-S. Ko, 2000a: Development of the high resolution, data assimilating numerical model of the Monterey Bay. In Spaulding, M.L. and H. Lee Butler (Ed.), *Estuarine and Coastal Modeling*, 980-994.

Shulman, I., C.-R. Wu, J.K. Lewis, J.D. Paduan, L.K. Rosenfeld, J.C. Kindle, S.R. Ramp, and C.A. Collins, 2000b: High resolution modeling and data assimilation in the Monterey Bay area. Continental Shelf Research, submitted.

TITLE: Implementation of SABSOON**Harvey Seim, Department of Marine Sciences, University of North Carolina**

Chapel Hill, NC 27599-3300

phone (919) 962-2083 email harvey_seim@unc.edu fax (919) 962-1254

SABSOON Partners and Roles:

Skidaway Institute of Oceanography - Systems design and deployment, cross-shelf exchange, bio-optics, geochemistry

TACTS, NWS, U.S. Navy - Helicopter support

University of North Carolina - Program management, physical oceanography, data assimilative circulation modeling, air-sea interaction

University of Georgia & Environmental Protection Agency - CDOM

South Carolina Department of Natural Resources - Fisheries management

Gray's Reef National Marine Sanctuary, NOAA - Diving support, fisheries studies

Award Made: FY 1998

OBJECTIVES

An interdisciplinary real-time coastal ocean observing network is being developed to provide users with continuous information on coastal ocean conditions. Resource managers and the weather service are using the routinely observed data to better predict and manage the use of the South Atlantic Bight (SAB) coastal waters. Academic researchers are using the network for targeted research and as a test bed for sensor development. The network will also provide in-situ observations for a NOPP-funded nowcast/forecast regional coupled ocean/atmosphere model of the SAB.

Offshore platforms owned and operated by the U.S. Navy are being instrumented with oceanographic and meteorological sensors. At each tower instrument systems are deployed which are for the most part readily serviced from the platform (i.e., without a ship or divers). Power is generated on-site, and data are relayed in real time by wireless communications to shore. Onshore, the observations are archived, processed, and distributed to various users. These currently include academic researchers and the National Weather Service. Recent observations are also made available through the web site (www.skio.peachnet.edu/projects/sabsoon.html).

The continuing implementation of the South Atlantic Bight Synoptic Offshore Observational Network (SABSOON) involves expanded deployment of data acquisition and sensor carriage systems at as many of the eight offshore platforms as possible, and refinement of an onshore data management and distribution system. We intend to develop a flexible offshore facility that can host a variety of scientific, educational and environmental monitoring activities. Unique aspects of the facility include coverage of more than 5,000 square km of the coastal ocean, ease of instrument servicing, ability to accommodate sophisticated instrumentation and relatively high bandwidth. A focus at this time is the design and deployment of communications and power systems at the outer more primitive towers where existing systems are insufficient to support the network.

WORK COMPLETED AND RESULTS

The first platform has been fully instrumented since October 1999 with two meteorological packages, in-water sensor packages, a surface wave/tide pressure sensor, and an underwater video camera system for fisheries studies. Hurricanes, severe winter storms and invasions of the Gulf Stream onto the shelf have been observed from the platform since that time, and it continues to operate well. Biofouling has proved to be the greatest impediment to maintaining the in-water optical sensors, and several antifouling schemes to mitigate the problem are being tested.

Phase 2 of the project, the extension of the network to multiple towers, is underway. Instrumentation of the second platform to be occupied in the network is now complete. A current profiler has been deployed since April 2000 that measures water velocities at 1 m vertical intervals from near the ocean floor to near the ocean surface. It is connected to the tower by cabling permitting real-time reporting of the current observations. Other instrumentation deployed in early September 2000 includes near-surface and near-bottom sensors to measure water level, ocean temperature, salinity, light intensity, turbidity and biological productivity. The support frame for the in-water sensor packages was re-designed to provide greater safety for operators, better accessibility to the sensors and better control of tension on the support cables. The new design builds on the experience gained from use of the first system. The new system was installed over the summer of 2000. Design of power and communication systems for a third more primitive platform is complete, and system components are being acquired and deployed.

The observational database is actively being analyzed. Meteorological instrumentation has revealed more than a dozen extreme wind events (>40 m/s) in spring and summer that appear to be marine downbursts. These events produce 5°C drops in air temperature in less than 6 minutes, implying severe downdrafts. Ocean temperature and salinity measurements document excursions of Gulf Stream derived waters onto the mid-shelf, and extended periods when fresher coastal waters have spread out to mid-shelf from the inner shelf. Both events occurred during wintertime when exchange between the nearshore, coastal ocean and deep ocean was thought to be minimal and suggest new mechanisms of cross-shelf exchange. Maxima in chlorophyll fluorescence, an indicator of biological productivity, occur during storm events when surface waves are large and light levels decrease significantly. The sandy sediments of the shelf support an abundant bottom microalgae community, and the fluorescence maximum is believed to be due to resuspension of the microalgae by surface waves. Such episodic resuspension of organic matter from the sediments, and subsequent transport by shelf currents, could be a significant mechanism of organic matter export from the shelf to the slope and deep ocean. Full-depth water velocity observations, collected since April 2000, provide further insight into shelf circulation and material exchange. Tidal currents are directed across shelf and low-frequency wind-forced flows are principally along the shelf, a combination that will produce complicated dispersion patterns of material (living and non-living) on the shelf.

TITLE: Coastal Marine Demonstration of Forecast Information to Mariners for the U.S. East Coast

Dr. Leonard J. Walstad, Horn Point Laboratory, University of Maryland Center for Environmental Science

Project Partners:

Dr. George L. Mellor, Princeton University

Dr. Isaac Ginis, University of Rhode Island
Mr. Glenn Szilagyi, Litton-Tasc
Mr. Joseph S. D'Aleo, Weather Services International
Dr. Frank Aikman III, NOAA, National Ocean Service
Dr. Laurence C. Breaker, NOAA, National Weather Service

Award Made: FY 1998

OBJECTIVE

To develop, improve, deliver and evaluate experimental marine forecast products for mariners of the Chesapeake Bay and surrounding coastal ocean.

ACTIVITIES/ACCOMPLISHMENTS

The Coastal Marine Demonstration Project (CMDP) was a two-year effort (August 1998 – July 2000), funded by the National Oceanographic Partnership Program. The CMDP developed, improved, delivered and evaluated experimental marine forecast products for mariners of the Chesapeake Bay and surrounding coastal ocean. The CMDP provided high-resolution model information, down to 800 meters, which was not otherwise available to users and forecasters. Important forecast parameters were surface winds, waves, water levels, currents, water temperature, salinity, visibility and ship ice accretion.

Two real-time demonstrations, each of about 2 months duration, were carried out during the summer of 1999 and winter/early spring of 2000. Six state-of-the-art forecast models were run in an operational mode to generate the forecast products. Model output was provided to four National Weather Service (NWS) forecast offices/centers. Nearly 5000 graphics of model output and observational data were generated daily and provided to dozens of diverse customers through a user-friendly Web site interface. Several users successfully made use of a CMDP-implemented, mobile system based on cellular wireless technology. During the demonstrations, an experimental National Ocean Service (NOS) estuarine forecast center was established to monitor execution of Bay models and provide a daily interpretation of model forecasts to users.

NWS forecasters and users provided useful feedback on model output guidance and Web products. Forecasters found water level, visibility, ship ice accretion, and coastal wave forecasts to be quite valuable and are continuing to use the operational versions of these products. Weather Forecast Offices (WFO) subjectively concluded that the Chesapeake Bay Regional Atmospheric Modeling System (CBRAMS) did a good job of handling local wind regimes, however it had problems handling synoptic scale patterns. A broad community of commercial, government, recreational and educational utilized the CMDP Web site responding with positive, enthusiastic feedback. A total of 41 individuals completed 83 evaluation forms. The most popular products were surface winds, waves and surface currents. Users were asked to rate eight different criteria which included timeliness, accuracy, usefulness, graphics, range of product selection, ease of site navigation, overall quality of site, and meets user needs. All criteria except one were rated by at least two thirds of the users as either good or excellent. Web site speed was rated lower because of users who accessed the Web via the relatively slow speed of the cellular wireless connection.

RESULTS/IMPACT

The CMDP concluded with two project reports^{1,2} and a list of eleven recommendations referenced to the *Chesapeake Bay*, the *Coastal Ocean* and *Dissemination*, listed below.

Chesapeake Bay

1. High resolution wind forecasts ((5 km) for estuaries/coastal ocean should be made operational as soon as possible.
2. Expand operational Chesapeake Bay models to include waves and currents.
3. Continue development of Chesapeake Bay 3-D Physical Oceanographic (C3PO) model.
4. Continue development of Bay wave forecast ability by deploying a wave buoy in the mid/lower Bay for comparison with CBWAVES and/or other wave model implementations.
5. Issue public text forecasts of water levels and currents for the Chesapeake Bay.
6. Consider issuance of warnings for extreme events (e.g. low water levels, strong currents).

Coastal Ocean

7. Continue to make improvements to the Coastal Ocean Forecast System (COFS) emphasizing features near the coast.
8. Establish operational transition criteria for COFS.
9. Expand COFS-type models to cover all U.S. coastal areas.

Dissemination

10. Publicize cellular wireless delivery for coastal mariners.
11. Push NOS products into mainstream formats and distribution channels by formatting NOS model output in WMO GRIB format and adding NOS products to NOAAPORT.

REFERENCES

1. CMDP 2000: *Science and Engineering of the Coastal Marine Demonstration Project*. Project Report, National Oceanographic Partnership Program, managed by the Office of Naval Research in collaboration with the University of Maryland Center for Environmental Science, Princeton University, University of Rhode Island, Litton-TASC, Inc., Weather Services International, NOAA's National Weather Service, National Ocean Service and Office of Oceanic and Atmospheric Research, and the U.S. Navy, 236 p.
2. Szilagyi, G.J., F. Aikman III and L.C. Breaker, 2000: *Evaluation of the Coastal Marine Demonstration*. NOAA Report, Silver Spring, MD, 39 p.

C. Observational Technique Development

TITLE: Monitoring Arctic Ocean Hydrography Using Autonomous Underwater Vehicles James G. Bellingham, Monterey Bay Aquarium Research Institute

Project Partners:

Dr. James G. Bellingham	MIT (now at MBARI)	AUVs, Project Lead
Mr. William Kirkwood	MBARI	AUV Design/Software
Dr. James E. Overland	Pacific Marine Environmental Lab.	Arctic Science
Dr. John Stannard	Fuel Cell Technologies, Ltd.	Fuel Cells
Dr. Peter J. Stein	Scientific Solutions, Inc.	Through-ice Comm.
Dr. Dana Yoerger	WHOI	Navigation, Comm.

Award Made: FY 1998

PROJECT OBJECTIVES

Our goal is to greatly increase access to the Arctic Ocean by creating and demonstrating a safe and economical platform capable of basin-scale surveys. Specifically, we are developing a Autonomous Underwater Vehicle for Arctic research with unprecedented endurance, and the capability to relay data through the ice to satellites. We will provide a means of monitoring changes taking place in the Arctic Ocean and investigate its impact on global warming. The vehicle will also be capable of seafloor surveys throughout the Arctic basin. Such a capability is of national and global interest and importance.

AUV development is focused on an initial experiment, which is to track the Atlantic layer intrusion into Arctic basin. We refer to the experiment as ALTEX for Atlantic Layer Tracking Experiment. ALTEX requires following the 1400 m isobath of the Nansen Basin, with occasional north-south excursions to probe the extent of the warm water intrusion. The vehicle will run at a depth of 275 m, but will obtain a full water column profiles on at least a daily basis. For this mission, the vehicle may not be recovered - data is reported by telemetry buoy. Ice thickness measurements are obtained during the telemetry buoy launch phase.

To create the desired Arctic survey capability, a number of technical challenges must be mastered. These include developing:

- 1) An AUV capable of reliably operating fully autonomously for periods of up to two weeks.
 - 2) A power source capable of driving a small vehicle at least 1000 km.
 - 3) Communication systems capable of being deployed from a small AUV, melting through the ice, and transmitting data back via satellite.
 - 4) Navigation systems capable of supporting extended high latitude AUV operations under ice.
- While the ALTEX mission requires only a 1500 m depth rating, the depth rating requirement for core vehicle systems has been set at 4500m, to enable access to most of the Arctic Ocean basin.

ACTIVITIES/ACCOMPLISHMENTS TO DATE

A modular AUV with parallel mid-body sections has been developed. The general AUV design approach is to minimize the use of pressure housings, putting as many systems as possible in smaller, lighter oil-filled (pressure compensated) enclosures resulting in a small, deep rated system.

The ALTEX vehicle is steered by an articulated tail section with a ducted propeller, in contrast with the more traditional control surfaces of previous vehicles. This approach is more robust to impacts (which usually occur on launch and recovery) and has significantly improved efficiency. Also worth noting is the fact that this system stays inside a 21" diameter. The vehicle has been tested in three configurations, from a minimum length vehicle (88 inches) to the full-length system (220 inches) in operations in Monterey Bay.

To achieve the desired range capability, we have developed a fuel cell energy system constructed by a team composed of Yardney Technical Products and Fuel Cell Technologies, Ltd. The system is unique in that it is pressure compensated and therefore deep-ocean rated. At the time of this writing, the fuel cell has accomplished a 170-hour continuous autonomous run in the test tank and is maintaining the expected parameters. Additional test tank tests are being used to ensure robustness. A full-scale fuel cell system will be integrated into the ALTEX vehicle for field tests in spring 2001. Communication from the vehicle to shore is provided by a battery of 13 expendable buoys, launched from the vehicle, capable of melting through the ice and transmitting stored data files via Argos. Tests of ice penetration were carried out using a full-scale buoy during the APLIS ice camp operated by ONR in early April 1999. The buoy balloons, required to raise the antennae after melt through, have undergone extensive testing, that has shown the balloon can maintain full inflation with a more than satisfactory safety margin.

The primary navigation system for ALTEX is an off-the-shelf INS, which is augmented with available estimates of vehicle speed, geophysical measurements (e.g. seafloor bathymetry, and magnetic field direction and strength). Orders have been placed for a Litton LN-250 INS. Bluefin Robotics is moving forward with the Cornerstone navigation project that the ALTEX project plans to take advantage of. The first units from Litton are expected to be in house by March of 2001. Follow-on funding for this project is being provided by the National Science Foundation for demonstrating the vehicle in Arctic operations. The first Arctic deployment of the vehicle will be in fall of 2001.

IMPACT/APPLICATIONS

While the developmental effort is presently focused on Arctic Ocean hydrography, this advanced vehicle can be used for a range of oceanographic applications. Other applications in the Arctic Ocean include seafloor mapping. Furthermore, in many ocean regions, the range and navigation capabilities provided by this vehicle would allow shore-based operations. The depth rating of the system allows the vehicle to be used for deep sea vent studies, studies of the sea floor spreading, exploration of the Antarctic ice shelf, and coupled observation/modeling systems in coastal and continental shelf environments. A range of military applications are also enabled, for example early, wide area battlespace characterization from platforms of opportunity.

TITLE: Autonomous Profilers for Carbon System and Biological Observations
James K.B. Bishop, EO Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS90-1116, Berkeley, CA 94720-0001

Project Partners:

Russ E. Davis and Jeffrey T. Sherman
Physical Oceanography Research Division

Scripps Institute of Oceanography
University of California, San Diego
and
Casey Moore
Western Environmental Technology Laboratories (WETLabs), Inc.,
PO Box 518, Philomath, OR 97370-0518

Award Made: FY 1999

OBJECTIVES

Our long-term goal is to understand the biogeochemical dynamics of the upper kilometer of the water column. Such an understanding is fundamental to the prediction of the processes partitioning carbon between atmosphere and ocean and to the redistribution of carbon and associated elements within the water column. Key to predictability is understanding day-to-day to seasonal variability of processes governing carbon species (dissolved and particulate, inorganic and organic) in the water column.

Our objective is to demonstrate the operational concept of low-cost autonomous profiling vehicles, outfitted with a suite of low-power optical, physical and chemical sensors. When widely deployed, these will permit high frequency four-dimensional observations of the variability of ocean biological processes, carbon biomass, upper ocean physics, and parameters of the carbon system in the upper 1000 m. It is envisioned that once proven, such vehicles can be widely deployed to explore carbon variability on global scales. To satisfy our objective we will demonstrate that we can explore carbon biomass variability in the water column on daily to seasonal time-scales in remote and extreme environments.

APPROACH

Platform. The autonomous platform to be used is the Sounding Oceanographic Lagrangian Observer (SOLO; Davis et al., 2000), a low-cost autonomous profiling float. This well-proven ocean physics platform, augmented with new optical sensors for biogeochemistry, will permit the rapid and precise determination of two important products of photosynthesis—particulate organic carbon (POC) and particulate inorganic carbon (PIC) -- as well as physical data (T, S and derived density stratification) relevant to understanding the variability of these products. SOLO will be modified to accommodate POC and PIC sensors and with ORBCOMM transceivers for bi-directional telemetry of data at much higher data rates than the previously used System Argos.

Implementation of the faster telemetry permits transmission of data from the expanded sensor suite while significantly reducing the time (and hence susceptibility to biofouling) of the float in the surface layer. SIO leads the modification of SOLO. Coordination and testing of the integrated float/sensor package is a joint effort led by LBNL and SIO. LBNL is responsible for calibration and data reduction.

POC sensor. Work at LBNL demonstrated that beam attenuation coefficient at 660 nm is strongly correlated with particulate organic carbon (POC) in open ocean waters. Accurate and precise long-term high-frequency measurement of POC in the upper 1000 m requires the following: (1) a stable and precise transmissometer (beam attenuation stable to better than 0.001 m^{-1}), and (2) effective antifouling protection for transmissometer optics. Work on these requirements is led by WETLabs.

PIC sensor. Particulate inorganic carbon occurs mostly as the mineral calcite and in most locations calcite is the dominant mineral in suspension. For this reason, we investigated optical properties (e.g. refractive index, birefringence...) specific to calcite that might be used to quantify PIC suspensions. LBNL is developing and proving the PIC sensor concept and WETLabs is implementing the PIC sensor concept in hardware and addressing biofouling issues.

ACTIVITIES

SIO completed the modification of SOLO with faster ORBCOMM telemetry and improved electronics for float control and acquisition of signals from an expanded sensor suite.

LBNL evaluated the PIC sensor concept using a bench-top spectrophotometer equipped with a 1-cm path length sample cell and modified with linear polarizers to measure the birefringence signal of CaCO_3 in mixtures with other suspended particles. Results showed that the method can be used, without further modification, to quantify PIC in waters where concentrations are high and CaCO_3 is a major component of total suspended material (e.g., surface ocean waters during coccolithophore blooms). Our results defined performance requirements and design parameters (e.g., path length) for an *in situ* instrument capable of operating over the entire oceanic range (0.02 to 30 mmol/kg) of PIC.

WETLabs has constructed a prototype 10 cm pathlength in-situ PIC sensor for SOLO and it is undergoing evaluation at LBNL.

LBNL (in cooperation with WetLabs, Inc. and SIO) began integrating sensors for particulate organic carbon (POC) and particulate inorganic carbon (PIC) with SOLO.

RESULTS

LBNL has submitted a manuscript describing the PIC sensor development; our results were presented at the Ocean Optics XV meeting; a patent on the PIC sensor concept is under development. The modified SOLO with integrated POC sensor and a prototype PIC sensor will be ready for testing at sea in early November 2000.

IMPACT/APPLICATIONS

The POC and PIC sensors and methodology employed in this project can easily migrate to other autonomous platforms; furthermore, the work of this partnership will lay the foundation for expanded sensor suites and their integration onto recoverable autonomous self-navigating platforms designed to quantify both the reactants and products of photosynthesis, and the rates of carbon-system processes.

TITLE: Low Cost Modular Telemetry For Coastal Time-series Data
Bradford Butman, Woods Hole Field Center, U.S. Geological Survey
384 Woods Hole Road, Woods Hole, MA 02543-1598
phone: (508) 457-2212 fax: (508) 457-2309 email: bbutman@usgs.gov

Project Partners:

Daniel E. Frye and W. Rockwell Geyer
Department of Applied Ocean Physics and Engineering

Woods Hole Oceanographic Institution
Woods Hole, MA 02543
phone: (508) 289-2759 fax: (508) 457-2154 email: dfrye@whoi.edu

Project Web Address: <http://dunkle.whoi.edu/webdata/LCT-Buoy/>

Award Made: FY 1998

INTRODUCTION

The objective of this 2-year project was to develop and demonstrate a low-cost system for retrieving oceanographic data from instruments in the coastal ocean and delivering these data over the World Wide Web in near real time. The system consists of 4 components: (1) a low-cost, acoustic data link from oceanographic instruments below the surface to a surface buoy; (2) an acoustic modem/radio frequency link to receive the acoustic transmissions and telemeter data to shore; (3) a buoy system for deployment of the system, and (4) a system for distributing the data over the World Wide Web.

The project was conducted cooperatively with the U.S. Geological Survey, Woods Hole Oceanographic Institution, RD Instruments, the Massachusetts Water Resources Authority, and the U.S. Coast Guard.

APPROACH

The telemetry and buoy system provides the potential of monitoring the coastal ocean on a variety of space and time scales and distributing the data over the WWW in a few minutes. The approach is to use very low cost, low power acoustic transmitters which are capable of transmitting data from many sensors located on a mooring line or on the bottom in the vicinity of a surface buoy. The receive system, located at the surface buoy, consists of an acoustic modem integrated directly with an radio frequency (RF) telemetry link capable of providing reliable data transmission at ranges up to 20 miles at modest data rates. Onshore, the data is distributed over the world wide web.

The system was tested in the field by transmitting Acoustic Doppler Current Profiler (ADCP) observations from two locations in Massachusetts Bay, offshore of Boston, Mass. The profiler, deployed on a tripod frame on the seafloor, measures currents from near-bottom to near surface in 2-m bins. One system is deployed on a Coast Guard navigation buoy in the Boston Approach channel in about 35 m of water. A second system is deployed offshore of Scituate, Mass. on a research buoy in about 25 m of water. These two mooring platforms provide a range of flexible options for deploying this system in coastal waters.

WORK COMPLETED

Design, construction, and testing of the system was completed in July 2000. The prototype Internet based data collection and display system can be viewed at <http://dunkle.whoi.edu/webdata/LCT-Buoy/>. A description of the system may be found in Frye and others, 1999 and Frye and others, 2000.

KEY RESULTS

- The acoustically linked coastal telemetry concept was demonstrated in prototype form in Massachusetts Bay. The moored surface buoys and other hardware are proving to be robust and

easy to use. To date, the Scituate mooring has been deployed for more than six months without any mooring related problems.

- Design and construction of the low-cost transmitter (LCT) required two years, longer than expected. As a result, the field trials used Utility Acoustic Modems (UAM) in place of the LCTs. We plan to substitute LCTs for the present UAMs on the ADCPs early this year.
- Rather than build the LCTs into the ADCPs, modems were built as stand-alone modules that could be plugged into existing instruments. This increased the flexibility of the LCT without complicating the logistics of the ADCP deployment. It also allowed an increased modem battery pack, which was needed to provide endurance for the operational system.
- The telemetry system on the stand-alone research buoy was successfully tested at the Scituate site twice during the spring and summer of 2000. Multipath problems caused higher than expected acoustic error rates and improvements in the acoustic link are being implemented for the next deployment to minimize these errors.
- The telemetry system was tested on the USCG Boston Approach Buoy in the summer of 2000. An electronic failure shortened this test. The system was re-deployed in September 2000. A robust and modular system was developed for deploying instrumentation on Coast Guard navigation buoys. This system included an over-the-side mount for the subsurface hydrophone as well as deployment of instrument housings on the buoy and RF antennas on the buoy tower.
- A real-time data processing and display capability was developed and is available via the project web site. Refinements to this page are ongoing. <http://dunkle.whoj.edu/webdata/LCT-Buoy/>
- The project goal was to develop an easy to use, reliable buoy and telemetry system that costs about \$10,000. Our estimate of the actual costs is about \$12,000 for the buoy and mooring system and about \$2500 for the LCT with its acoustic source and battery. Labor associated with system preparation and test is in addition to these materials costs.

IMPACT

The development of the low cost telemetry system has the potential to provide observations from distributed arrays with multiple sensors on a wide variety of spatial scales. Such observations are needed to resolve key processes, for ocean prediction, to aid in developing optimal sampling strategies (particularly for coupled physical and biological studies), and for long-term monitoring. There has been considerable interest in this telemetry system, and it is being utilized on the Northern Gulf of Mexico Littoral Initiative (NGLI) to collect real time current profiles to improve real time circulation models of the Gulf.

FUTURE PLANS

The telemetry system is being further refined and tested in the field during the period 2000-2001 at both the Scituate and Boston sites. During this period, we plan to use a lower carrier frequency, a modified frequency-hopping table, and improve the shore-side processing routines to improve data quality.

PUBLICATIONS

Frye, D. von der Heydt, K., Johnson, M., Maffei, A., Butman, B., 1999, New Technologies for Coastal observatories, Sea Technology, 29-35.

Von der Heydt, Butman, B., Frye, D., Johnson, M. Maffei, A., Lerner, S., 1999, Portable Coastal Observatories, (abs.), EOS Transactions, 80 (49), p. OS151.

Frye, D., Butman, B., Johnson, M., von der Heydt, K., Lerner, S., Portable Coastal Observatories, 2000, Oceanography, v. 13, No. 2/2000, p. 24 - 31.

TITLE: Development of an Autonomous Sampling Network for Plankton, Hydrography and Currents. Phase I. Incorporation of Plankton Imaging Capability into Autonomous Underwater Vehicles

Cabell S. Davis, Woods Hole Oceanographic Institution

Project Participants and Responsibilities:

Davis, Cabell

Dr. Davis is overall project leader and is in charge of general oversight of engineering and field sampling components of the project. He will work with Gallagher and Goldsborough in designing the field program and in data collection and analysis.

Gallagher, Scott

Dr. Gallagher is participating in all aspects of the engineering design and development and will be working with Davis and Goldsborough in coordinating the field sampling, including ground truthing, and data analysis.

Goldsborough, Robert

Goldsborough is the head engineer on the project and is leading the effort to integrate the VPR into REMUS. He is working closely with Pierre Tillier at SeaScan Inc., Gallagher, and Davis in the design and construction of the system. He will participate in the field program and in data analysis in Year 2.

Organizational Partners:

Seascan, Inc.

Pierre Tillier, Engineer and owner of SeaScan Inc., collaborated with Davis and Gallagher in development of the original Video Plankton Recorder. In this project, Mr. Tillier is working closely with the three co-PIs in developing a smaller VPR system to interface to REMUS. He is a subcontractor on the project but is also donating 2 weeks of his engineering design time to the project. His engineering expertise and familiarity with the VPR system is invaluable to the project.

New England Aquarium Corporation

The New England Aquarium will be a partner next year during the field testing phase to document our field study and develop a small public exhibit at the Aquarium.

NOAA Stellwagen Bank Marine Sanctuary

The Sanctuary office will participate by documenting the field study to aid in its public outreach program.

Other Collaborators or Contacts:

We have contacted many technical specialists at Sony, Hitachi, Momentum Inc. and other companies in researching the best components for our new VPR/REMUS system.

Award Made: FY 1999

PROJECT ACTIVITIES AND FINDINGS

The single biggest challenge in Biological Oceanography over the next two decades is development of predictive capability. At present, this capability is limited by the sparseness of our data and our inability to sample with high enough resolution in time and space to capture episodic features that control population size. In the present project we are developing an autonomous high-resolution sampler by merging plankton-imaging technology with autonomous underwater vehicle (AUV) technology. We are integrating the Video Plankton Recorder (VPR) into the REMUS AUV.

Phase I of this project involves abstracting the design of the VPR and incorporating the underlying principals into hardware that can be carried by a neutrally buoyant fully autonomous underwater vehicle. Since REMUS has been designed with sufficient forethought to allow modest instrumentation packages to be added, this becomes a tractable design task. The design challenges for this part of the program fall into two main areas, 1) repackage the camera and strobe light from the VPR along with their optical components into small lightweight pressure housings that attach to REMUS, and 2) assemble a data recorder electronics package that can accept the video signal from the VPR, store up to 10 hours of imagery on a hard disk, while fitting into REMUS. Each of these design tasks is currently under way.

Based on experience gained from a separately funded program that uses compressed video data recording, a small and compact wavelet based compressed video recorder is being assembled for installation within the REMUS vehicle. This self-contained video recorder consists of a PC-104 single board computer, a commercial wavelet compression board and a high capacity hard disk drive. Together these components will be mounted on a carrier board that contains power supplies and a control interface. To date, wavelet hardware has been assembled for bench testing and software development. Development of a software program to control the recorder and collect ancillary data to be recorded along with the video data is in progress.

The main components of the VPR are the video camera and synchronized strobe light, each with a specialized optical system. These are installed in two pressure housings that are attached to the body of REMUS. We are currently working on the camera selection, and selection of the optical components, which together determine the requirements for the pressure housing. The strobe light electrical design is based on existing hardware that will be laid out to fit the new housing, as determined above. The housing design will start as soon as camera selection is made.

OUTREACH ACTIVITIES

After the VPR-Remus integration is completed, we will conduct field testing of the new system. During this field testing, personnel from New England Aquarium and NOAA Stellwagen Bank Marine Sanctuary. The results will be used in public outreach by these organizations.

CONTRIBUTIONS WITHIN DISCIPLINE

The VPR-REMUS system has the potential to revolutionize plankton sampling and monitoring. The field testing phase of the project will be next year.

CONTRIBUTIONS TO OTHER DISCIPLINES

The VPR-REMUS system is designed to provide autonomously collected high-resolution data for plankton, hydrography, currents in near real time. Such data will prove invaluable to a wide range of disciplines from numerical modeling to ecological management in both freshwater and marine systems.

CONTRIBUTIONS TO HUMAN RESOURCE DEVELOPMENT

The public displays to be developed will educate the public as to the technology advances being made to study the environment as well as to the ecological information being acquired used to further our understanding of the pelagic marine environment.

BEYOND SCIENCE AND ENGINEERING

The new VPR-REMUS system will provide high resolution data that can be used in decision making regarding coastal pollution such as eutrophication effects of sewage outfalls.

TITLE: Ocean-Systems for Chemical, Optical, and Physical Experiments (O-SCOPE)
Tommy Dickey, Ocean Physics Laboratory (OPL), University of California, Santa Barbara (UCSB)

Project Partners:

N. Bates, Bermuda Biological Station for Research, Inc. (BBSR), Bermuda
R. Byrne, University of South Florida (USF), St. Petersburg, FL
F. Chavez, Monterey Bay Aquarium for Research Institute (MBARI), Moss Landing, CA
R. Feely, Pacific Marine Environmental Laboratory (PMEL), Seattle, WA
C. Moore, WET Labs, Philomath, OR
R. Wanninkhof, Atlantic Oceanographic and Meteorological Laboratory (AOML), Miami, FL

Award Made: FY 1998

The National Ocean Partnership Program (NOPP) sponsored Ocean-Systems for Chemical, Optical, and Physical Experiments (O-SCOPE) project has addressed the need for next-generation, autonomous, near real-time, nearly continuous, long-term, time-series measurements in critical regions of the world ocean. The program's general objective is to improve the variety, quantity, quality, and cost-effectiveness of observations in anticipation of a global ocean observing network of strategically placed moorings and other ocean platforms. Benefits and impacts of O-SCOPE include the development of technologies to quantify seasonal, interannual, and decadal changes in upper ocean biogeochemical, bio-optical, and physical, variables. These variables bear on understanding and predicting global climate change and its impacts on ocean biogeochemistry and ecology.

Basic NOPP O-SCOPE objectives were to: 1) identify key variables to be measured, determine capabilities and limitations of available sensors, and define specifications for next-generation sensors, 2) design, develop, and test integrated interdisciplinary systems for biogeochemical, bio-

optical, and physical measurements (e.g., low-cost, easily deployed, reliable, robust), 3) design a testbed mooring program (e.g., deployment scheduling, sampling rates, instrument placement depths, etc.), 4) deploy next-generation interdisciplinary instrument suites on three moorings, and 5) evaluate performances of new instrumentation and telemetry systems.

Sensors measuring a host of interdisciplinary variables from moorings can be configured to provide a continuous early warning system to global change in the ocean. O-SCOPE is capitalizing on a variety of recent technological advances (e.g., pCO₂, dissolved oxygen, pH, and alkalinity sensors, nitrate analyzers, spectral optical sensors, and data telemetry) to accelerate the implementation of a plan to instrument (i.e., network) critical regions of the world ocean with long-term interdisciplinary moorings. Data obtained from a mooring network of time-series observations can be spatially extrapolated using remote sensing, complementary shipboard, drifter, float, and glider sampling, and models. A vision for the future is to develop an integrated system for enabling near real-time world ocean data distribution to the oceanographic community for education as well as research via the internet. We have utilized ongoing testbed mooring programs near Bermuda (i.e., Bermuda Testbed Mooring; BTM) and in Monterey Bay, as well as existing measurement programs, capabilities, and facilities for biogeochemical, bio-optical, and physical sensor development, testing, and seatruthing. New instrumentation has also been deployed on a NOPP-NOAA Tsunami warning system mooring at Ocean Weather Station “P” (OWS “P”) in the North Pacific Ocean; ship-based measurements have also been conducted at the site for sensor groundtruthing and study of spatial variability in the vicinity of the mooring. It is important to emphasize that few ocean sites exist where long-term (more than 40 years) measurements are being done at present; the OWS “P” and Bermuda sites are two of these. The two sites are thought to be very important in terms of the CO₂ system. In particular, there are strong indications of increasing pCO₂, consistent with increasing atmospheric levels, at these sites and the Hawaii Ocean Time-series (HOT) site; thus, many biogeochemical modeling studies utilize data sets from these locations.

KEY SPECIFIC RESULTS

Nick Bates (BBSR) has focused on groundtruthing (e.g., verification) of chemical sensors deployed on the BTM. An important component was done in collaboration with Liliane Merlivat (University of Paris VI) on the analysis of seawater pCO₂ data collected from an autonomous buoy system (i.e., Carbon Interface Ocean Atmosphere; CARIOCA), tethered to the BTM. Nearly co-located concurrent ship-based seawater pCO₂ data were also collected. The CARIOCA buoy pCO₂ data were determined to be accurate to within ± 3 matm compared to shipboard measurements. The importance of high frequency sampling was highlighted by significant variability on hourly to 8-day time scales (e.g., inertial, diurnal, synoptic weather patterns, and mesoscale processes). Another collaborative effort was done with Mike DeGrandpre (University of Montana at Missoula) as DeGrandpre’s Submersible Autonomous Moored Instrument (SAMI) pCO₂ system was deployed on the BTM. Comparisons of pCO₂ and DpCO₂ data collected by Gernot Friederich and YSI, respectively, with ship-based data are in progress and appear promising.

Bob Byrne (USF) has developed and tested an autonomous in situ spectrophotometer, Spectrophotometric Elemental Analysis System (SEAS), for measurement of seawater pH from ocean moorings. Observations of seawater pH allow quantification of the extent of anthropogenic CO₂ uptake in the surface ocean. SEAS was configured for measurements of the absorbance ratios of pH sensitive indicator dyes. The system autonomously mixes seawater and indicator dye, records absorbances at three wavelengths within the liquid core waveguide spectrophotometer cell, and

communicates with external electronics for data transmission via the GOES system to shore-based facilities. Comparisons of the pH of seawater measured in the laboratory using both the SEAS in situ system and a conventional shipboard system indicated agreement to within approximately 0.008 pH units. The deployment of the SEAS pH sensor on the NOPP OWS “P” mooring was the first deployment of an autonomous spectrophotometric pH measurement system at sea. To summarize, the USF work included observations of instrument precision and accuracy in the laboratory, development of autonomous data acquisition and transmission capabilities, and demonstration of instrument durability during the OWS “P” mooring deployment.

Francisco Chavez and Gernot Friederich (MBARI) led the mooring program at MBARI. They have developed a pCO₂ measurement system, which has been tested on the O-SCOPE moorings. Major technical advances concerned the development of a new controller board, a new gas inlet system for the pCO₂ sensor, and data telemetry capability. Analyses of data collected with these systems have demonstrated their effectiveness in a variety of oceanic conditions. In particular, the most recent testing at the BTM has led to results suggesting that the usual summertime sea surface CO₂ supersaturation was interrupted during most of July 2000 when pCO₂ returned to near atmospheric values. The pCO₂ decrease may have been coupled with a regional cooling event. In autumn, temperature and pCO₂ decreased concurrently. Ongoing studies at the MBARI M1 mooring have demonstrated that a one-year service interval can be achieved for the DpCO₂ apparatus. A major advance by the MBARI group involves development of a proto-type system for measuring absolute air and sea surface pCO₂ and dissolved oxygen along with a UV nitrate sensor (Ken Johnson, MBARI). The MBARI group also shared information concerning development of anti-biofouling mechanisms; this has expedited development of similar systems for other sensors and systems by UCSB and WET Labs partners. Some of the new MBARI instruments are now being utilized on NOAA Tropical Atmosphere-Ocean (TAO) moorings in the equatorial Pacific.

Dick Feely (PMEL) led groundtruthing efforts, collecting background datasets for sensor verification and contextual interpretation, for the region around the NOPP OWS “P” mooring as well as coordinating the mooring program there. Accomplishments included defining geochemical parameters for ship sampling and characterizing horizontal and vertical gradients in physical and biogeochemical variables near the site. Underway measurements included salinity, CO₂, DIC, temperature, pH, nutrients, chlorophyll, and oxygen. Water column measurements included salinity, CO₂, alkalinity, DIC, temperature, nutrients, and oxygen. Dick Feely and Cathy Cosca (PMEL) also developed a website for the O-SCOPE program, <http://www.pmel.noaa.gov/oscope/>, and a near real-time data telemetry, display, and distribution system.

Rik Wanninkhof (AOML) tested a new dissolved oxygen sensor and also obtained remote sensing data for the OWS “P” region for seatruthing activities. This study concerned the problem of measuring dissolved oxygen. These measurements are most effective when done at high sampling frequency; however, the problems of instrument drift and storage of calibration samples have long plagued researchers. A second-generation permeable membrane pulsed electrode dissolved oxygen system built by Chris Langdon (LDEO) was utilized. Attributes of the new system enable longer term deployments in biologically productive waters. New probes were tested on the R/V Ron Brown and were subsequently deployed on the BTM and the R/V Weatherbird II. Results show excellent agreement between the BTM and ship-based data sets. A new sample storage scheme was developed with successful storage periods of up to 4 months. Rik Wanninkhof has also tested an

autonomous (36 samples) water sampler and evaluating the stability of CO₂, O₂, and nutrient samples.

Casey Moore (WET Labs) developed a modular sensor suite for bio-optical sampling for extended deployments. These include two new sensors: a chlorophyll fluorometer and a multi-angle scattering (volume scattering function, VSF) sensor. The instruments also featured new anti-fouling shutters for longer term deployments. The fluorometer allows the user to monitor chlorophyll concentration. The fluorometer uses two bright blue LEDs to provide the excitation source. The optical scattering sensor measures scattering from particles at 100, 125, and 140 degrees concurrently. Through interpolation, specific angles of scattering can then be matched to reflectance models used for remote sensing. The fluorometers and the scattering sensors collected data successfully during extended deployments with the UCSB bio-optical instrument suites. The most recent deployment was for 4 months from the BTM and results indicate high fidelity and little signal degradation due to biofouling. The WET Labs effort has led to a commercial line of products and served as the foundation for another NOPP project involving a Virtual Mooring Glider.

Tommy Dickey and the Ocean Physics Laboratory (OPL; UCSB) have developed new optical systems in collaboration with Satlantic (Marlon Lewis and Scott McLean). New servo-controlled copper anti-biofouling shutters were engineered for the radiometers and successfully tested. A suite of sensors was deployed at the NOPP OWS "P" site in October 1999. A three-wavelength surface radiometer deployed at 7 m was sampled once per hour and a digital data stream was stored in memory. The radiometer system was cabled to the NOPP buoy's data logger. Once per day the radiometer sensor system was successfully interrogated by the PMEL surface data telemetry system for subsequent transmission by the GOES satellite system. A near real-time data archive was then generated for the O-SCOPE website. An identical sensor suite and logging system was deployed at 15 meters. Using the BTM, the OPL used systems to measure surface irradiance and radiance at 7m and 15m along with WET Labs fluorometers and three-wavelength backscatter sensors. OPL also coordinated the BTM testing and the O-SCOPE project.

SUMMARY

The O-SCOPE project has facilitated the formation of a successful partnership which has been used to develop, test, and transition requisite next-generation technologies to the oceanographic community for long-term measurements and research of biogeochemical and bio-optical as well as physical processes. Several new chemical and optical systems for mooring (and potentially other platforms) have been developed and tested. We have completed the field testing phase with deployments of the various systems from three mooring sites: Bermuda (BTM), Monterey Bay (MBARI), and OWS "P" in the North Pacific. The O-SCOPE project has accelerated interdisciplinary ocean measurement technology capabilities by 1) increasing the variety of variables which can be measured autonomously, 2) improving the robustness and reliability of interdisciplinary sampling systems, 3) reducing adverse biofouling effects on chemical and optical systems, and 4) developing a system for near real-time telemetering and dissemination of data via the internet. Some of the important transitions to date have included the use of newly developed instrumentation on the NOAA Tsunami Warning System Mooring located at Ocean Weather Station "P" in the Pacific and two NOAA Tropical Atmosphere-Ocean (TAO) moorings in the equatorial Pacific as part of the NOAA Global Carbon Cycle Program and the commercialization of newly developed optical instruments which are benefiting other NOPP projects.

TITLE: Ocean Response Coastal Analysis System (ORCAS)
Dr. Percy L. Donaghay, University of Rhode Island

Project Partners:

- University of Rhode Island - Project coordination; profiler development and deployment; physical, biological, optical data collection and analysis; focus on episodic events, thin plankton layers and harmful algal blooms
- WET Labs, Inc. - Development of intelligent controller and data acquisition systems for the autonomous profiler winch and sensor packages; development of mini-optical, CTD sensor systems; on-site field support
- SubChem Systems - Development and field deployment of in situ nutrient analyzers and data analysis; investigation of event-driven nutrient dynamics, hypoxia, thin plankton layers and harmful algal blooms; assistance with University of Rhode Island project coordination
- Naval Research Laboratory - Coordination with Navy research optics programs; participation in mooring validation and diver exercises; data processing/evaluation; algorithm development; transition of results to Navy
- Commander, Naval Meteorology and Oceanography Command - Coordination with operational Navy objectives; divers for in-water visibility and vulnerability exercises; development and transition of operational product; ship arrangements and cost
- Environmental Protection Agency - Coordination with EPA-Gulf Ecology program objectives (hypoxia, HAB); integration and deployment of Fast Repetition Rate Fluorescence with University of Rhode Island profiler, and data analysis

Award Made: FY 1999

PROJECT DESCRIPTION:

The partnership will develop, test, and demonstrate ORCAS, a system of ship-deployed and autonomous moored bottom-up profilers for coherent, real-time monitoring of multiple biological, physical, chemical, and optical parameters within the ocean, in 3-D space and time. The innovative profiling technology combines small intelligent underwater winch and sensor controllers, miniaturized sensors for inherent optical properties, and profiling nutrient analyzers. The high-resolution profilers will be readily deployable for determination of the coastal environmental response to episodic events such as storms, nutrient inputs, hypoxia, and algal blooms.

Two types of autonomous profiling packages are planned. The first is a compact, but highly integrated, profiler featuring miniaturized sensors for CTD and optics. This smaller, lower-cost package will allow easy deployment individually or as a horizontal array of several bottom-up profilers that provide broad spatial coverage. The second profiler package will be comprised of a comprehensive suite of high-resolution physical, chemical and bio-optical sensors. It will be deployable either from a surface ship or a mooring. Intelligent controllers and telecommunications modules will allow autonomous operation, in situ data processing, and real-time data telemetry to a base computer, and internet dissemination. Collected data will be used to generate 4-D fields of information; in turn these fields can be used to generate useful environmental products.

TITLE: A Near-Real-Time, High-Resolution Ocean-Surface-Current Mapping System

Jack Harlan (original PI: Thomas Georges), NOAA Environmental Technology Laboratory/Science and Technology Corporation

Project Partners:

NOAA Environmental Technology Laboratory

U.S. Navy Fleet Surveillance Support Command

Raytheon Electronic Systems

University of Colorado - Colorado Center for Astrodynamics Research

Award Made: FY 1998

PROJECT OBJECTIVES

- Develop and demonstrate over-the-horizon (OTH) radar technology for near-real-time current mapping over areas of millions of square kilometers using U.S. Navy radar systems
- Provide high spatial resolution of the flows into/out of the Gulf of Mexico (GOM) and disseminate on the Web
- Analyze and compare OTH-derived currents with in situ drifting buoys and satellite altimetry-derived currents
- Develop efficient current-mapping algorithms that will minimize radar usage and maximize ocean coverage

ACTIVITIES/ACCOMPLISHMENTS

- High-resolution current maps of the inflow to the GOM were put on the Web approximately weekly (<http://www1.etl.noaa.gov/othr/99rothr.html>). Note that, at times, ionospheric disturbances caused poor data quality so that reliable current maps could not be posted on the Web.
- Comparisons of OTH-derived currents with in situ drifting buoys and satellite altimetry-derived currents were made for times during Fall 1998; shipboard current meter data from a March 1999 cruise were also compared. Both tests covered the GOM inflow region.
- Numerous algorithms were tested for their ability to obtain accurate current measurements while using less radar time, a primary constraint on NOAA use of Navy systems.

RESULTS/IMPACT

- We demonstrated that OTH-derived currents accurately portray the complex flow into/out of the GOM by comparison with ship, satellite and drifting buoy data. The OTH-derived currents exhibit 1) a southward flow near the western tip of Cuba, 2) eddies in the middle of the Yucatan Channel, 3) small slower eddies along the southern shelf of Cuba. All these features have been verified by drifter data and the differences between the drifter and OTH data agree with published results. Furthermore, these results suggest that a complex circulation indeed exists in the GOM inflow/outflow region. This new knowledge should help to improve circulation models of the GOM, an important effort for U.S. oil and fishing industry interests and hurricane generation/intensification research.
- An unexpected benefit of the altimetry-OTH comparisons was the revelation that the real-time smoothing algorithm used by TOPEX/POSEIDON investigators is not as accurate as that used for its archival processing.
- Simulated radar data were subjected to both the algorithm presently used by Raytheon and more modern *iparametric* algorithms (subcontracted to Dr. R. D. Palmer, University of Nebraska Electrical Engineering Dept.). For determining radar-derived velocities, the parametric algorithms

were shown to be more accurate than the conventional one. These same algorithms, applied to the design of a hypothetical OTH radar, indicate a cost-to-build reduction factor of 1/4.

- Radar data from the inflow/outflow of the GOM were collected by Raytheon (an unfunded partner) approximately once per week until October 1999 when Raytheon software problems commenced precluding further collection to the present time. This lack of data has prevented us from testing the parametric signal processing algorithms on real data. Thus, we were unable to investigate their utility in making more efficient use of our limited radar access. Additionally, the anticipated doubling of radar coverage using available software was not implemented by Raytheon. ...

SUMMARY

This NOPP project has demonstrated that accurate current-mapping is possible with OTH radars and that these maps are able to resolve small scale features that conventional measurements only suggest and that satellite measurements average out or even overlook. Extensive testing with simulated data indicates that, given access to more radar data, we could achieve higher accuracy in our current measurements. Given that the primary role of existing OTH radars is drug interdiction and that our results show that less costly radars are possible, we suggest that further research be directed toward building an OTH system dedicated to ocean and atmospheric research. Toward this goal, a NOAA SBIR has already been awarded to Codar Ocean Sensors Ltd., who have built a limited working prototype during its Phase I. Further NOPP work remains for refining and expanding the ocean observing functionality of the prototype to demonstrate its value in an Integrated Ocean Observing System.

TITLE: Incorporation of Sensors into Autonomous Gliders for 4-D Measurement of Bio-optical and Chemical Parameters

Dr. Mary Jane Perry, University of Maine

Project Partners:

Dr. Charles C. Eriksen, University of Washington, co-PI

Mr. Casey Moore, Western Environmental Technologies Laboratories

Dr. J. Ronald Zaneveld, Western Environmental Technologies Laboratories

Dr. Emmanuel Boss, Oregon State University

Dr. Nordeen G. Larsen, Sea-Bird Electronics, Inc.

Dr. Jan Newton, Washington State Department of Ecology

Dr. Randolph Shuman, King County Department of Natural Resources

Award Made: FY 1999

PROJECT OBJECTIVES

The goal of this partnership is to extend development of an autonomous underwater glider that can measure ocean properties continuously in remote locations and relay the data home in almost real time. The Seaglider is a buoyancy-driven underwater vehicle that travels through the upper ocean along a sawtooth path. A key advantage of the Seaglider is low power consumption, allowing it to sustain missions lasting from several weeks to several months. The primary objective of this project is to develop and incorporate miniaturized sensors into the Seaglider for measuring concentrations of phytoplankton, suspended particles, and dissolved oxygen on the same space and time scales as temperature and salinity. The newly-instrumented Seaglider will be tested in diverse environments

with extensive ground-truthing to verify the high quality of the data collected. Field tests in Puget Sound, Washington, will also contribute to understanding the dynamics of key physical, biological and chemical parameters that are essential to assessing human impacts on water quality. The long-term goal of the partnership is to develop a smart glider that will be useful and affordable for basic oceanographic science investigations as well as for applied studies.

ACTIVITIES/ACCOMPLISHMENTS TO DATE:

Sensor development: The primary issues of concern for sensors to be integrated into the Seaglider are size, power consumption, and stability. During the past year, the efforts in optical sensor development focused on development of miniaturized low-power circuitry and on size reduction of the fluorometer (to measure phytoplankton concentration) and the backscattering sensor (to measure a proxy for particle concentration). The initial sensor included only a fluorometer embedded in a flush-mounted removable puck that was designed to minimize drag on the glider body. This sensor was deployed on one Seaglider in Monterey Bay, California, in August 2000. Subsequently, a combination sensor with a single source and dual detector was developed that added a backscattering detector to the same physical space. This combination sensor was deployed in Puget Sound, Washington, in January 2001. Parallel efforts to reduce the electronics and incorporate them in a single puck are proceeding. The phase two plan includes development of a total scatter sensor.

Seaglider deployment: In 2000 the Seagliders were deployed in three major field activities and operated autonomously for up to one month. Two Seagliders were instrumented with temperature and salinity sensors and a third with the additional oxygen and optical sensors. In different deployments the Seagliders were operated in one of two modes, either a transect mode in which they traveled along specified paths or a “virtual mooring” or station-keeping mode in which they maintained position. In both modes they dependably telemetered data immediately following each dive cycle. The deployments demonstrated the ability of the Seagliders to autonomously sample temperature, salinity, phytoplankton biomass and dissolved oxygen in complex environments; to operate within complex topographic and current regimes; to accept and follow new instructions from a remote control center; to maintain position; and to estimate both depth-averaged and surface currents. Several talks reporting results of glider deployments have been presented at national and international meetings.

ANTICIPATED RESULTS/IMPACTS:

The anticipated result of this project is the full integration of optical and dissolved oxygen sensors into a fully operational autonomous underwater glider capable of operating in diverse environments for extended missions. The Seaglider will contribute to climate studies, delivering long-term observations of ocean temperature and other properties at a fraction of the cost of ships. These observations will enable the responses of phytoplankton to climate change to be studied. By observing the vertical distribution of optical properties, the Seaglider will provide information on the vertical structure of ocean properties to complement surface satellite observations. The Seaglider has tremendous potential to contribute to monitoring water quality in coastal and estuarine waters; the ability to operate continuously will allow episodic events to be observed. The ability of the Seaglider to accept commands from a remote control center will provide great flexibility for water quality sampling programs. The sensors developed for the glider will be available for other platforms and major programs for observing the oceans.

D. “Commons” for Ocean Information

TITLE: The Prediction of Wind-Driven Coastal Circulation

J. S. Allen and J. A. Barth, College of Oceanic and Atmospheric Sciences, Oregon State University

Project Partners:

Senior Investigators at OSU: J. Allen, J. Barth, T. Boyd, D. Caldwell, G. Egbert, A. Huyer, P. M. Kosro, M. Levine, R. Miller, J. Moum, R. Samelson, E. Skyllingstad, H. Wijesekera

Government Partners: W. Peterson (NOAA NMFS, Newport), J. Wilczak and J. Harlan (NOAA Environmental Technology Laboratory, Boulder)

Industrial Partners: J. Svejksky (Ocean Imaging), D. Barrick and B. Lipa (CODAR Ocean Sensors)

Award Made: FY 1998

OBJECTIVES

To understand the dynamics of, and to build a predictive capability for, wind-driven mesoscale oceanographic processes (2-50 km horizontal space scales, 2-10 day time scales) over the continental shelf as influenced by temporal and spatial variability of the atmospheric forcing, by spatial variability of the continental margin, and by internal mixing related to small-scale turbulence. The ocean variability of interest includes the physical processes associated with energetic alongshore coastal jets, upwelling and downwelling fronts, and eddies.

ACTIVITIES/ACCOMPLISHMENTS

This project combines modeling, data assimilation and an observational program off Oregon. High-resolution, limited area three-dimensional coastal ocean circulation models are being applied to an Oregon coastal region for direct simulations, data assimilation and process studies. A regional atmospheric model is used to estimate surface forcing fields and to study the dynamics of the coastal lower atmosphere using triply nested grids. The ocean models are being forced by observed winds and heat flux and also by fluxes from the regional atmospheric model and the results compared with observations. A practical sequential data assimilation system has been developed for implementation with the ocean model.

The observational program includes long-term measurements from the OSU Coastal Radar System presently deployed near Newport. During summer 1999, NOAA ETL partners expanded the land-based radar coverage (J. Harlan) and obtained vertical wind profiles using an upward-looking RASS profiler on the coast (J. Wilczak). Satellite-sensed sea surface temperature and roughness are being made available by Ocean Imaging (J. Svejksky). Bi-weekly hydrographic and zooplankton sampling was conducted off Newport by NOAA NMFS (W. Peterson). CODAR Ocean Sensors (D. Barrick, B. Lipa) worked on testing the feasibility of improving the direction-finding capabilities of their standard SeaSonde antenna.

Additional measurements by OSU PIs included observations of temperature, salinity, chlorophyll fluorescence and light transmission from over 20 cross-shelf sections off Newport obtained using a small towed, undulating vehicle (MiniBAT). During May to August 1999, three moorings equipped

with current, temperature and conductivity sensors throughout the water column were deployed off Newport. One of the moorings measured atmospheric variables. Moored observations are being used to study the response of the coastal ocean to wind forcing and to verify the numerical ocean models.

A three-week cruise aboard the R/V Wecoma was made during July 1999. High-resolution hydrographic, bio-optical, velocity and microstructure data throughout the water column were collected in a region near Newport. The hydrographic and velocity fields are being used to initialize and provide ongoing data for assimilation into the coastal model. Over 12,000 CTD profiles obtained using the towed vehicle SeaSoar have been used to form vertical sections and horizontal maps which, when combined with shipboard ADCP velocity measurements, are being used to investigate mesoscale dynamics. Measurements of the Inherent Optical Properties (IOP) are being used to estimate chlorophyll, sediment, and colored dissolved organic concentrations and to relate their distributions to physical features (upwelling front, submarine banks, Columbia River plume, etc.) and to SeaWiFS imagery.

The microstructure data are being used with the model to assess the role of small scale turbulence in determining the mesoscale structure of the flow and hydrographic fields. Over 1300 profiles of turbulence parameters and light backscatter are being used to estimate bottom stress and to investigate details of the bottom boundary layer over the shelf.

RESULTS

Comparison of atmospheric model results with observations suggests that the model performed sufficiently well to provide useful estimates of wind stress in regions where wind measurements were not available. The model alongshore wind stress increases by factors of 3-4 from north to south along the Oregon coast.

Ocean model results for the continental shelf circulation are in good agreement with observations on the shelf. Results from the model studies show improved agreement of modeled and observed velocities with forcing by the spatially variable winds from the mesoscale atmospheric model compared with forcing by spatially uniform buoy winds.

The effectiveness of the assimilation system has been demonstrated by assimilating land-based radar derived surface currents into the ocean model and comparing the analyzed sub-surface velocities over the mid-shelf to independent observations. Significant improvement is found with the assimilation, demonstrating the utility of predicting subsurface fields given knowledge of the wind forcing and surface velocities measured from land with radar.

A measure of upwelling intensity based on cross-shelf vertical sections obtained through the upwelling season off Newport was developed. This measure was found to be highly correlated with an upwelling index formed by taking an exponentially weighted running mean of the alongshore wind stress. This relationship can be used to predict when subsurface waters will be exposed at the sea surface.

The 3D SeaSoar hydrographic surveys show that the wind-forced, southward coastal upwelling jet follows the Heceta Bank topography as it widens offshore. The jet reaches the southern end of the Bank, where the shelfbreak turns almost 90 degrees back toward the coast. This flow-topography

interaction creates pressure gradients that, following wind relaxations, drive flow back to the north. This leads to northward flow on the inshore side of the Bank and even recirculation around the entire Bank system. Sections across the shelf upstream and downstream of a midshelf submarine bank demonstrate the role of bottom topography in directing the alongshelf upwelling jet offshore and mixing the overlying water column. Each of these processes, recirculation, offshore flux of shelf water and mixing, has a significant influence on coastal ocean ecosystem dynamics.

TITLE: ZooGene, A DNA Sequence Database for Calanoid Copepods and Euphausiids: An OBIS Tool for Uniform Standards of Species Identification
Ann Bucklin, University of New Hampshire

Project Partners:

Bruce W. Frost, University of Washington, Seattle, WA

Peter H. Wiebe, Woods Hole Oceanographic Institution, Woods Hole, MA

Michael J. Fogarty, NOAA/NMFS NE Fisheries Science Center, Woods Hole, MA

Project Web Address: <http://www.ZooGene.org>

Award Made: FY 2000

PROJECT SUMMARY

An international partnership has been established to develop a zooplankton genomic (ZooGene) database of DNA type sequences for calanoid copepods and euphausiids. The ZooGene partnership includes four principal investigators and thirteen expert taxonomic consultants from seven countries. Zooplankton samples are being sorted from existing archival collections, obtained in coordination with planned oceanographic research efforts, and collected during National Marine Fisheries Service field surveys. The taxonomic experts are confirming species' identifications; DNA sequencing is being done at the University of New Hampshire and, in some cases, in other partners' laboratories. For each species, a DNA type sequence is being determined for a portion of the mitochondrial cytochrome oxidase I (mtCOI) gene; multiple mtCOI sequences will be included as necessary to reflect intraspecific variation. The ZooGene database is being designed, created, managed, maintained, and distributed as part of the proposed work; the data will be integrated into the Ocean Biogeographical Information System (OBIS). Operational and research uses the ZooGene database include: 1) uniform standards of species' identification, 2) evaluation of the taxonomic significance of geographic variation within widespread species, 3) identification of cryptic species, 4) accurate estimation of species' diversity, 5) determination of evolutionary relationships among species, and 6) design of rapid molecularly-based species' identification protocols.

Education and outreach efforts include: training of graduate students at UNH and UW; a hands-on Molecular Systematics Workshop at UNH during Summer, 2002; exchanges between the P.I.s, international partners, and their colleagues and students; inclusion of ZooGene molecular and environmental data in the OBIS database, and others; creation and maintenance of a project web site; production of a CD with the ZooGene database and simple search tools; and development of a ZooGene curriculum module for high school students by the NH Sea Grant Marine Docents.

OBJECTIVES OF THE ZOOGENE PARTNERSHIP

- establish a nexus of taxonomic experts for calanoid copepods and euphausiids, with focused effort on selected genera and regions
- determine mtCOI type sequences for 200 species of calanoid copepods and 86 species of euphausiids, based on verified identification of species by taxonomic authorities
- design, create, and manage the ZooGene database, a searchable web-based database integrated with the GenBank DNA sequence database and OBIS, as a tool for uniform species identification
- design and implement a ZooGene curriculum module for high school students

WORK COMPLETED

New ZooGene collections: ZooGene partners have collected and shipped to UNH comprehensive sets of samples for molecular analysis. Samples are in hand for the copepod genera: *Paracalanus* and *Tortanus*, collected and identified by Susumu Ohtsuka (Hiroshima University, Japan); *Acartia*, collected and identified by David McKinnon (Australian Institute of Marine Science, Australia), with additional collections planned by Janet Bradford-Grieve (National Institute of Water & Atmospheric Research, New Zealand), and *Pseudocalanus*, collected and identified by Bruce Frost (University of Washington, USA) and Fredrica Norrbin (Tromsø University, Norway). Euphausiid samples are in hand from Shozo Sawamoto (Tokai University, Japan) and Jaime Färber Lorda (Centro de Investigación Científica y de Educación Superior, Mexico). Detailed planning is underway for ZooGene collections in association with Ecosystem Monitoring Surveys by the NOAA/NMFS NE Fisheries Science Center to assess spatial and temporal variation in gene frequencies in selected taxa.

DNA sequences of calanoid copepods: We have determined mtCOI type sequences for 34 species of six calanoid genera. These sequences have been submitted to GenBank and are the subject of two publications: Hill et al. (2001) and Bucklin et al. (in preparation). MtCOI sequences have proved to be diagnostic molecular systematic characters. In addition, the sequences are likely to resolve large-scale population genetic structure, racial and other subspecific differentiation, and cryptic species, based on preliminary analysis of three geographic populations of *Calanus helgolandicus* and two subspecies of *C. pacificus* (Hill et al., 2001; Bucklin et al., in preparation). MtCOI sequence variation resolved evolutionary relationships among most species, although the most distantly-related species were not well resolved.

DNA sequences of euphausiids: Determination of the mtCOI type sequences is complete for 14 species in eight genera of euphausiids. A manuscript summarizing this work has been accepted with revision for publication in the *Journal of Marine Research*. The sequences will be submitted to GenBank in the near future. MtCOI is a diagnostic molecular systematic character for euphausiid identification, and also resolves evolutionary relationships among congeneric species with statistical significance.

These studies confirmed that species of calanoid copepods and euphausiids - whether sibling species or species of different families - are readily distinguishable based on mtCOI sequence variation, which is thus a valid systematic character. Further, the levels and patterns of sequence variation are suitable for the design of rapid molecularly-based species' identification protocols, such as competitive species-specific Polymerase Chain Reactions (PCR).

EDUCATION AND OUTREACH

Several education and outreach activities are ongoing for ZooGene:

- Preliminary efforts are underway to organize a comprehensive systematic and molecular systematic workshop for calanoid copepods and euphausiids - now targeted for August, 2002. The workshop is being integrated into efforts to address critical needs for taxonomic expertise in diverse marine taxa.
- At the University of Washington, a graduate student has begun studies toward the Masters' degree. Her planned research will focus on one aspect of ZooGene.
- A ZooGene molecular kit and curriculum module are being designed and implemented for use in New Hampshire high schools; an informative brochure for teachers has been produced. A NH Sea Grant Marine Docent is taking the lead in this effort, scheduled for introduction to the schools in Fall, 2001.
- A project web site, <http://www.ZooGene.org>, has been established. The web site provides general information on the partnership, as well as technical information to guide colleagues in collecting and preserving zooplankton for molecular analysis. We are exploring approaches to integrating the planned ZooGene database with the comprehensive molecular database, GenBank.

Publications resulting from this award to date:

Hill, R.S., L.D. Allen, and A. Bucklin (2001) Multiplexed species-specific PCR protocol to discriminate four N. Atlantic Calanus species, with a mtCOI gene tree for ten Calanus species.

Marine Biology (in press)

Bucklin, A., S.B. Smolenack, J.J. Pierson, and P.H. Wiebe (2001) Population genetic diversity and structure of the euphausiid, *Stylocheiron elongatum*, in the Gulf Stream, with a molecular phylogeny of six *Stylocheiron* species. Journal of Marine Research (in revision)

Bucklin, A., L.D. Allen, B.M. Seppa, B.W. Frost, and J. Bradford Grieve (in preparation)

Molecular systematic assessment of twenty-four calanoid copepod species of the Calanidae and Clausocalanidae using DNA sequences of mtCOI and nuclear 18S rRNA.

TITLE: HYCOM Consortium for Data Assimilative Ocean Modeling

Eric P. Chassignet, University of Miami

Rosenstiel School of Marine and Atmospheric Sciences, 4600 Rickenbacker Causeway, Miami, FL 33149

Project Partners:

University of Miami Rosenstiel School of Marine and Atmospheric Science (UM/RSMAS)

Naval Research Laboratory (NRL)

National Oceanic and Atmospheric Administration Atlantic Oceanographic and Meteorological Laboratory (NOAA/AOML)

University of Minnesota

Los Alamos National Laboratory (LANL)

Service Hydrographique et Océanographique de la Marine (SHOM)

Planning Systems Inc.

Orbital Image Corp.

U.S. Coast Guard

Project Web Address: http://panoramix.rsmas.miami.edu/hycom_nopp/

Award Made: FY 1999

The HYCOM Consortium for Data-Assimilative Ocean Modeling is a multi-institutional effort funded by the National Ocean Partnership Program (NOPP) to develop and evaluate a data-assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (called Hybrid Coordinate Ocean Model or HYCOM). The hybrid coordinate, in the context of this work, is one that is isopycnal in the open, stratified ocean, but smoothly reverts to a terrain-following coordinate in shallow coastal regions, and to p-pressure coordinates in the mixed layer and/or unstratified seas.

The primary purpose of the consortium is the establishment of a global real-time ocean forecast system based on HYCOM, with sophisticated data assimilation techniques that can be efficiently executed on massively parallel computers. The consortium seeks to address both the US-GODAE (Global Ocean Data Assimilation Experiment) principal objective, namely the depiction of the three-dimensional ocean state at fine resolution in near-real time, as well as the climate modeling objective of producing an unbiased estimate of the state of the ocean at coarse resolution for long-term climate variability research.

The emphasis of the work performed during the first year was on the building blocks of the consortium, i.e. the numerical model, the data assimilation techniques and the quality of the data to be assimilated.

- HYCOM 1.0 was released in August 2000. HYCOM 2.0, which will be released in February 2001, is more versatile (i.e. can run on a variety of computer platforms) and incorporates additional capabilities such as open boundary conditions, true global domain, better input/output capabilities.
- Several data assimilation techniques are presently being ported to HYCOM. They consists of (1) an optimal interpolation of the model/data sea surface height combined with a vertical projection of the surface information and (2) reduced order implementations of the full Kalman filter.
- One of the main difficulties associated with the use of sea surface height anomalies measured from satellites is the lack of a temporal mean. A poor mean will introduce large errors in the ocean forecast. An optimal mean field was therefore generated by using a rubber-sheeting technique that merge the model mean with the best observational data.

The anticipated results from this effort include integrated analyses/reanalyses for research programs, a foundation for model enhancement based on testing of hypotheses, and improved open-ocean nowcasts and forecasts with application to search and rescue, shipping routes, tracking of icebergs and major pollutants, commercial fisheries, etc.

TITLE: Modeling the Central California Coastal Upwelling System: Physics, Ecosystems and Resource Management

Francisco P. Chavez, Monterey Bay Aquarium Research Institute

Project Partners:

A. De Vogelaere (MBNMS), Y. Chao and Y. Song (NASA/JPL), J. McWilliams and P. Marchesiello (UCLA), R. Maffione (Hobi Labs), J. Kindle (NRL), J. Paduan (NPS), F. Chai (U. Maine), B. Marinovic (UCSC), R. Barber (Duke) and J. Ryan (MBARI).

Award Made: FY 2000

PROJECT OBJECTIVES

- (1) To develop a high-resolution coastal model that will simulate physical, chemical, and biological processes within the Monterey Bay National Marine Sanctuary (MBNMS). The coastal model will be nested within regional and basin-scale models and will assimilate global ocean nowcasts and data from satellite and in situ sensors.
- (2) To apply model results to solve practical coastal ocean-related problems.
- (3) To provide information to local, state and federal agencies for coastal ocean management, planning and policy.

ACTIVITIES/ACCOMPLISHMENTS TO DATE

- The observational base for model validation has been established from the extensive MBARI and California Cooperative Fisheries Investigation (CalCOFI) databases.
- The coastal model has been configured, and computing resources for model testing have been expanded. Results from previous regional modeling efforts from the NOPP/ICON program are being incorporated into model design.
- Initial model validation has focused on comparison of model results with long-term mean seasonal conditions observed along two transects.
- The ecosystem model has been developed to include additional chemical tracers, and it has been coupled with the physical model. The carbon dioxide component of the model has been parameterized with relationships derived from MBARI observations.
- Solar radiation forcing of the model system has been investigated to determine if forcing fields available from government and academic institutions accurately represent conditions measured at MBARI moorings within the MBNMS.

ANTICIPATED RESULTS/IMPACT

- The rich historical database and excellent matrix of real-time ocean observing systems available within the MBNMS will foster development of the next generation of coupled coastal physical-biological models.
- The model will enable the managers of the MBNMS to fulfill their mandate of promoting “resource protection, research, education, and public use.” Long-term (decadal and longer) model simulation and prediction will contribute to policy, and short term simulation will guide management. Model results will also direct future observational efforts within the MBNMS.
- The project will establish cooperative relationships between government, academic, non-profit and industrial institutions that will benefit future research efforts.

TITLE: Development of an Integrated Regional, National and International Data System for Oceanography

Peter Cornillon, University of Rhode Island

Project Partners:

Mark Abbott, Oregon State University

Anders Andren, University of Wisconsin

Brad Butman, Coastal and Marine Programs (USGS)

Richard Chinman, University Corporation for Atmospheric Research (UCAR)

Don Collins, Jet Propulsion Laboratory (JPL/NASA)

James Cummings, Naval Research Laboratory (NRL)

Margaret Davidson, Coastal Services Center (CSC/NOAA)
Glenn Flierl, Massachusetts Institute of Technology
Dave Fulker, UNIDATA/UCAR
James Gallagher, University of Rhode Island
Ted Habermann, National Geophysical Data Center (NGDC/NOAA)
Peter Hamilton, Science Applications International Corporation (SAIC)
Steve Hankin, Pacific Marine Environmental Laboratory (PMEL/NOAA)
Chris Lynnes, Goddard Space Flight Center (GSFC/NASA)
Linda Mercer, Department of Marine Resources, State of Maine
Richard Lawrence, Environmental Systems Research Institute, Inc (ESRI)
Worth Nowlin, Texas A&M
Lola Olsen, Goddard Space Flight Center (GSFC/NASA)
Herve Roquet, Météo-France, France
Neville Smith, Bureau of Meteorology Research Centre (BMRC) Australia
Ken Tenore, University of Maryland
Ken Turgeon, Minerals Management Service (MMS)

Award Made: FY 2000

PROJECT OBJECTIVES

The overall objective of this effort is to plan and implement a network based system that will provide for the discovery of and seamless access to oceanographic data. The project consists of two phases:

- 1) In the first year community consensus will be sought for the basic system and the system will be designed at a high level, and
- 2) In the second and third years, the system conceived in the first year will be implemented.

In that many of the components required to build such a system already exist, the planning process will focus on determining the modifications that might be required for these components as well as on defining components that are missing. The implementation will focus on assembling these components into an integrated system.

ACCOMPLISHMENTS TO DATE

Five regional workshops and one national workshop were to be undertaken in the first year to obtain input from the oceanographic community. In addition four subcontracts have been let for the installation of system servers at selected sites, one subcontract has been let for the development of a system web crawler and one subcontract has been let to begin work on bridging the gap between geographic information systems (GIS) and scientific information systems (SIS). For a variety of reasons it took longer to let these subcontracts than originally anticipated; work on them is only beginning at this time.

Three of the regional workshops have been held:

- The Gulf Coast Workshop, led by Worth Nowlin, was held on 31 October through 2 November 2000 in Stennis, Mississippi. The final report for this workshop has been completed and is available.
- The Southeast Workshop, led by Ann Ball, was held on 15-17 November 2000 in Charleston, South Carolina.
- The Northeast Workshop, led by Linda Mercer, was held on 8-10 January 2001 in West Greenwich, Rhode Island.

The West Coast Workshop, led by Mark Abbott, is scheduled for 17-19 January 2001 in Corvallis, Oregon.

The Great Lakes Workshop was replaced by a topical workshop focusing on GIS-SIS issues. This workshop held in Redlands California on 7-8 November 2000 was led by Ted Habermann as part of the subcontract to USGS for GIS-SIS linkage.

The picture that has emerged from the workshops that have been held to date is that the data access protocol of the Distributed Oceanographic Data System (DODS) is adequate for the data types expected in the Virtual Ocean Data Hub (VODHub) system. The weaknesses of DODS relate primarily to data discovery and to client side programs. This results primarily from the lack of a mandated metadata standard in the system. These two issues, along with others that emerge as the workshop reports are completed, will form the basis for the dialog to be undertaken at the National Workshop. The National Workshop has not yet been scheduled, but it is anticipated that it will be held in the Washington, DC area in April 2001.

ANTICIPATED RESULTS/IMPACTS OF THIS PROJECT

When complete this project will:

- 1) have designed and implemented an infrastructure for the VODHub system, an integrated - interoperable - oceanographic data environment,
- 2) linked in excess of two terabytes of oceanographic data held in over 250 datasets at approximately 40 sites via this system,
- 3) established a diverse group from the ocean data user community committed to the success of the system, and
- 4) built the basic infrastructure required to couple data providers and users in the science community with data providers and users in the GIS community.

TITLE: Census of Marine Fishes (CMF): definitive list of species and online biodiversity database

William N. Eschmeyer, Department of Ichthyology, California Academy of Sciences

Primary Project Partner:

FishBase, International Center for Living Aquatic Resources Management (ICLARM)

Other Project Partners:

Taxonomic experts, various museums and collection managers, various governmental agencies such as ITIS (Integrated Taxonomic Information System).

Award Made: FY 2000

The purpose of this project is to "Advance the Ocean Biogeographical Information System for the Census of Marine Life with respect to marine fishes." The project is for 2 years, from June 1, 2000 - May 30, 2002.

PROGRESS ON GOAL 1

(to provide an accurate on-line world checklist of marine and brackish water fishes)

Work continued on the Catalog of Fishes database maintained at the California Academy of Sciences. An assistant was hired in early September to work with the Principal Investigator and technical assistant. Earlier editions of this database are in printed form (“Catalog of Fishes,” 3 vols. 2905 pp. 1989), and at www.calacademy.org/research/ichthyology. On a daily basis new literature sources that document the status of species of fishes (such as valid, or a synonym of another species) and new species (about 250 per year) are entered—this is preparatory to the development of the on-line world checklist. Some books, such as “Fishes of Bermuda” may take a week to go through species by species to enter pertinent information in the database. During the 7-month period, a total of 511 books and journal articles were entered (ref. 24502-25013). Style changes were nearly completed as well, and a new version is expected to be posted electronically in February 2001 and will have a major impact, since it will be a complete and improved synopsis of all 55,000 species of fishes that have been described and named (about 25,000 are valid species, and about half of these are marine species). At the same time, the primary partner, FishBase, is a major database (over 12,000 hits per day in 1999) that provides information on taxonomy, biology, ecology, occurrence and utilization of fish. The Catalog of Fishes information is incorporated in their www site as well, and the November version of the Catalog of Fishes database was received and a preliminary matching against species in FishBase and the Catalog of Fishes was begun. The FishBase staff, supported by the project, also continued to enter references on status, occurrence, and biology (especially tracking marine and brackish water species). They added 356 new species for a total of 25,128 valid species as of Nov. 2000. During the same time, 1,558 synonyms (valid names, new combinations, misspellings) were added to the list of synonymous fish names (used in improving data in collection databases). Their scope and information may be seen at www.fishbase.org. Also, the FishBase staff created a preliminary on-line interface with a fish biodiversity database, and this can be seen at www.fishbase.org/SearchFishCollections.cfm. The contract between FishBase and the California Academy of Sciences was finalized and signed. The partner PI (Rainer Froese) and the PI considered possibilities for information that can be provided to meet or exceed objective 1, including the addition of other information for each species, such as marine habitat type, important synonyms, etc.

PROGRESS ON GOAL 2

(an online biodiversity database of fish occurrences, based on specimen collections and integrated with key information on biology and ecology)

Fishbase is taking the lead in this goal. Under the direction of PI Froese and the FishBase www manager, they have begun creating dot distribution maps based on occurrence information. A preliminary version was completed during the reporting period and can be viewed at www.fishbase.org/search.cfm. An effort was and is being made to obtain geo-reference information on the millions of preserved fish specimens in collections of fishes worldwide. Several new collections were added. The two most important collections/countries to undertake major marine vessel collections in the last 40 years will participate—the collection in Hamburg, Germany is partially funded by FishBase to computerize their collection. In late December 2000, the California Academy of Sciences and the Laboratory of Oceanic Ichthyofauna, of the Russian Academy of Sciences in Moscow signed a contract to begin computerization of the Moscow fish collections with funds from the present project; their collections like the German ones are extremely important and unique; they had no funds available for computerization. The important collections in Paris and London, other foreign collections and a number of American collections also participate. Other

collections will be approached over the next year. Fishbase now contains records from 12 major fish collections with over a half a million records. The records listed in the result of each online search are linked to the contributing collections databases if there are available online. A number of additional collection databases have been received for future inclusion in the biodiversity database.

PROGRESS ON GOAL 3

(software that will assist collection managers to improve the quality of collection databases)

Data quality (identifications, coordinates, etc.) is important for the success of the overall project. The FishBase staff works directly with specialists to verify identifications and status of species using a “Check Names” routine that was improved during the reporting period. The FishBase staff worked directly with collection managers to improve their collection information and identifications—printouts resulting from the routine were shared with collection managers. Software has been assembled that will use algorithms to assign levels of reliability to identifications.

A collaboration agreement was negotiated with the Fishnet Project of Kansas University (another project in the present program using a different mapping strategy). Under this agreement, collection managers are encouraged to work with Fishnet as well as with FishBase to make their data available publicly. Information was provided to ITIS, and plans for making data transfer more easy were considered. Specialists continued to work with FishBase and the Catalog of Fishes personnel on taxonomic questions.

TITLE: Biogeoinformatics of Hexacorallia (Corals, Sea Anemones, and Their Allies): Interfacing Geospatial, Taxonomic, and Environmental Data for a Group of Marine Invertebrates

Daphne Gail Fautin, University of Kansas

Project Partners:

Individuals

Robert W. Buddemeier, Kansas Geological Survey, co-Principal Investigator

Adorian Ardelean, University of Kansas, USA - developing the synonymy tool

Stephen D. Cairns, Smithsonian Institution, USA - providing data for Scleractinia

Laura David, Bits & Parity, Manila, Philippines - entering data for Scleractinia

Tina Molodtsova, Shirshov Institute of Oceanology, Russia - providing data for Ceriantharia

John Ryland, University of Wales, UK - providing data for Zoanthinaria

J. E. N. Veron, Australian Institute of Marine Science, Australia - providing data for Scleractinia

Institutions

LOICZ (IGBP), Netherlands

ICLARM, Malaysia

NCRI (Nova University), Florida, USA

NOAA, USA

Project Web Address: www.kgs.ukans.edu/Hexacoral/

Award Made: FY 2000

OBJECTIVES

To link biogeographic information across spatial scales, greatly augmenting the minimal biogeographic data available for most benthic marine invertebrates; to permit formulation and testing of biogeography and biodiversity models; and to support forecasting and hindcasting of distribution changes due to environmental alteration.

To accomplish these goals, we focus on hexacorals, members of phylum Cnidaria that include sea anemones and reef-forming corals. Specifically, we will:

- 1) Create a taxonomic database to all species except Antipatharia (black corals); these belong to orders Corallimorpharia and Actiniaria (sea anemones; already compiled by Fautin), Ceriantharia (tube anemones), Scleractinia (“stony” or “true” corals), and Zoanthinaria (zoanthids). Specimen-based, it will contain three-dimensional distribution data (including geospatial precision of each record) and bibliographic reference to the description of each species.
- 2) Develop an application to permit retrieval of data by all synonyms of a species, flagging taxonomic and nomenclatural problems.
- 3) Allow interaction of this database with physicochemical and ecological databases important to marine biogeography. The core databases will be those assembled and linked as part of the UNEP/GEF-funded program within the LOICZ (IGBP) Typology effort (www.nioz.nl/loicz).
- 4) Develop and adapt tools to allow interactive analyses of the biological and environmental data, including by visualization on map displays.

ACCOMPLISHMENTS (1 September 2000 - 10 January 2001)

Environmental database and analytical tool development: In cooperation with, the partner project LOICZ (Land-Ocean Interactions in the Coastal Zone; IGBP), the world ocean and coastal zone were gridded into 0.5 degree cells to provide a geographical basis for database design. This resolution is the most realistically useful compromise between coastal and open-ocean environments, and between desired resolution and the available data and methods. Of 259,200 half-degree cells on the earth’s surface, 49,683 are “coastal zone” cells, which extend about one degree seaward and landward of the shoreline. The remaining oceanic cells (about 120,000) are included to provide complete coverage for the OBIS program. Distribution of cells in relation to the coastlines is shown on maps at water.kgs.ukans.edu:8888/public/Typpages/typcells_1.htm.

The database currently contains about 70 environmental variables selected for expected uses, drawn from publicly available global coverages, and adapted to format requirements; they include location, and atmospheric, oceanic, geomorphic, population, and terrestrial variables (the latter two are relevant to assessment of marine impacts but not to the ocean itself).

In addition to the data provided by modern technology, historical data will be added (where available) in the form of measurements such as bottom temperature and substratum type for sites where specimens were collected. The structure also serves the needs of other partner projects and will:

- classify coastal and marine environments in a conceptually useful fashion;
- permit integration and consistent analysis of available global data sets dealing with land, sea, air, and human dimension variables;
- operate at a scale of resolution useful for the data and applications envisioned; and
- provide a manageable number of data points for analysis and global upscaling or extrapolation.

For internet use, a front end for the database has been developed at www.kgs.ukans.edu/Hexacoral/index.html. This provides access to the component databases and their walkthrough pages. Although the geospatial linkage of the biogeographic and taxonomic databases to the environmental variables will be the focus of attention after all the taxonomic data are entered, substantial progress has also been made in development and incorporation of the LoiczView geospatial clustering tool. The database and LoiczView sites are password-protected during development. A general “access to information” presentation for the database and clustering tool, as well as image-based tutorials, are accessible at www.kgs.ukans.edu/Hexacoral/Workshops/jump.html; legitimate users can request passwords from the Principal Investigators.

Taxonomic database and analytical tool development:

An database (biocomplexity.nhm.ukans.edu/anemones/images/Version.html) containing information on sea anemones that was originally in Access was modified in Oracle to accommodate growing demands on it. Use of Oracle allows contribution of data from multiple collaborators simultaneously. Current NSF funding to Fautin under the PEET program (Partnerships to Enhance Expertise in Taxonomy) has permitted adding all uses of names of sea anemones to those from the original descriptions, which were already in the database. Collaborators Cairns, Molodtsova, and Ryland, along with Hazel Loaring, student of Ryland, and three interested others, attended a workshop at the University of Kansas (KU) during the first week of November to learn the database and provide feedback to Keith Hunsinger, a PEET-supported student who is the Systems Administrator for the project. Molodtsova remained through November to add all data on adult cerianthids; she will visit KU next August to add data for larvae. Ryland and Loaring should soon complete entry of zoanthid names and references. Fautin visited Veron in Australia during October to obtain his data on scleractinian corals. During the latter half of December, Laura David was at KU to learn functionalities of the system for addition of data on scleractinians.

Ardelean has finalized the synonymies application, Syngraph, thanks to input from collaborators during their visits to KU. Syngraph was alluded to in the article by Fautin in the October 2000 issue of “Oceanography” that was devoted to OBIS—Electronic atlas of sea anemones: an OBIS pilot project. At the annual meeting of the Society of Integrative and Comparative Biology (4-7 January, Chicago), Ardelean, Fautin, and Hunsinger presented a poster about it. A manuscript describing Syngraph is nearly ready for submission. Help files, image-based tutorial, and download pages for Syngraph are available at web.nhm.ukans.edu/inverts/syngraph/index.htm.

As part of an atlas and gazetteer that will enhance the geographical portion of the database, Hunsinger is developing a method for expressing precision of locality data. The issue was discussed at the OBIS meeting in Rhode Island in September. A convention will soon be arrived at that is agreeable at least to Census of Marine Life projects FishBase and CephBase, in addition to our hexacoral project.

Database implementation:

Both components of the hexacoral database are running on the Oracle server at the Kansas Geological Survey. Queries are being designed in ColdFusion by Girmay Misgna. Portable versions have been extracted into Microsoft Access (and into an Oracle version running on a laptop) to permit testing and application at remote locations, and in preparation for distributable free-standing

(CD-ROM) versions for use at sites wishing to adapt and apply the concepts and tools. These versions are currently in test and development in a series of UNEP-GEF sponsored LOICZ workshops. To provide feedback opportunities for the user community, e-mail links are provided on the websites, and a discussion board has been established at www.kgs.ukans.edu/Hexacoral/discutions.html.

TITLE: Real-Time Forecasting System of Winds, Waves and Surge in Tropical Cyclones
Hans C. Graber, University of Miami

Project Partners:

University of Miami: Mark A. Donelan, Michael G. Brown

Florida Atlantic University: Donald N. Slinn

US Army Corps of Engineers: Robert E. Jensen

NOAA/AOML: Peter G. Black, Mark D. Powell, Sam H. Houston

National Hurricane Center: John Guiney

Oceanweather, Inc.: Vincent J. Cardone, Andrew T. Cox

Sun Microsystems, Inc.: Christopher Paluszek, David Dew

Award Made: FY 1999

PROJECT OBJECTIVES

The long-term goal of this partnership is to establish an operational forecasting system of the wind field and resulting waves and surge impacting the coastline during the approach and landfall of tropical cyclones. The results of this forecasting system would provide real-time information to the National Hurricane Center during the tropical cyclone season in the Atlantic for establishing improved advisories for the general public and federal agencies including military and civil emergency response teams. The feasibility of such a forecast system has been established over the past decade from the development of the individual modules for winds, waves and surge. These modules have been tested independently over the years and are now ready to be linked into a complete forecasting system. This project focussed on the planning activities for the functional description of the forecasting system, establish the acquisition of data sources, the computing requirements, design the interfaces and define model output products. Finally, the entire system is tested via a proof-of-concepts approach with a case study of Hurricane Georges (1998) in the Gulf of Mexico.

ACTIVITIES/ACCOMPLISHMENTS

The estimation of tropical cyclone-generated waves and surge in the coastal waters and nearshore zone is of critical importance to the timely evacuation of coastal residents, and the assessment of damage to coastal property in the event that a storm makes landfall. The model predictions of waves and storm surge in coastal waters are functionally related and both depend on the reliability of the atmospheric forcing. Snapshot wind fields of tropical cyclones derived from the aircraft flights become the basis for accurate description of the storm characteristics in the wind analysis system. These winds form the initialization for the interactive objective kinematic analysis (IOKA) methodology that is capable to evolve in space and time the sub- and mesoscale features in a developing cyclone (e.g. surface wind jet streaks). The successful use of these winds in wave

prediction models produced unprecedented accuracies in the hindcasted skill of storm peak wave heights in extratropical and tropical storms.

The third-generation spectral ocean wave model, WAM, is the choice model to predict and forecast the directional wave properties. The model is implemented in a nested configuration to increase the spatial resolution when approaching land and for providing the wave-induced effect on the storm surge. One of the most striking affects imposed on the coastal environment during a hurricane is the rise in water level caused by surge effects. This can have catastrophic implications overtopping the beach, the dunes, and eventually impacting coastal structures. Accurate storm surge modeling near coastlines requires coupling between the waves, tides, and surge as well as accurate estimates of the time-dependent water depth which affects the wave forecasts. On opposite sides of the eye of a hurricane the storm surge can change sign and affect the local water depth by several meters, strongly influencing wave height predictions. The accurate parameterization of the surface wind stress and the resulting waves are essential elements for storm surge models. The wind-induced surge forced by the wind stress depends directly on the waves via height and wave age. The wave-induced setup is coupled to the storm flow dynamics. Clearly, uncoupled models would systematically under-predict surge.

We have accomplished the following:

1. Selection and specification of model grids, boundary conditions, and regional scale information for Hurricane Georges (1998) as it entered the Florida Straits and Gulf of Mexico. The forecasting system was applied to Georges until land-fall near Biloxi, MS.
2. Generation of two sets of wind fields: a) wind fields derived from the in-situ flight measurements from the hurricane hunters providing high-resolution details of the tropical cyclone wind fields in irregular, but frequent intervals; and b) wind fields derived from the IOKA methodology using observed tropical cyclone parameters.
3. Wave predictions on nested grids were made with the WAM model and included both wind fields described in 2). Results were compared with buoy mean parameters and directional wave spectra.
4. The chosen storm surge model was implemented on finite element grid with high-resolution detail in the bayous and embayments along the coastline. Surge predictions were made with both wind fields described in 2), but without coupling the effect of the waves. The model was extensively tested using various. Additional elements describing coupling between water and air and the seabed must still be implemented in the model.
5. All official track predictions, advisories and intensity forecasts were assembled for additional simulations. Schedule of data and information sequence as needed by National Hurricane Center were established.
6. Two meetings: 1) to kick off project, define tasks and scope of work and 2) to discuss progress and results. We have also identified additional new partners who want to participate in this project.

ANTICIPATED RESULTS/IMPACT

The preliminary results of the real-time forecasting system for winds, waves and surge in tropical cyclones show considerable skill and promise to provide in a timely manner critical information to the National Hurricane Center for better advisories and warnings to local, state and federal emergency agencies and the general public. The challenge of crisis managers and emergency planners is to relocate an ever-increasing coastal population from the path of destructive tropical cyclones within the amount of time allotted by present prediction skills. Currently viable means do

not exist in many coastal regions to translocate large portions of its residents in a short time out of harm's way. The only alternative is to improve the prediction and forecasting skills by extending the number of hours of warning. We believe that we can do it.

We see three unique products arising from this partnership. Perhaps the most important is the effort to assess the impact of a tropical cyclone forecasting system in real-time operational conditions. The experience gained through the efforts of this partnership will accelerate not only the transition of these technologies to operational use, but also provide the "best" wind and/or wind stress fields over the coastal ocean for forcing other ocean models. The second is that this partnership will develop the most advanced state-of-the-art real-time tropical cyclone forecasting system. The synergism arising from the collaboration with industry will provide substantial added value not only to this partnership, but also and most importantly to the general public. Finally, displays of data obtained from this state-of-the-art forecasting system will enhance science education, public and environmental awareness.

TITLE: Modeling and Data Assimilation for the Study of Puget Sound, Washington
Mitsuhiro Kawase, University of Washington

Project Partners:

School of Oceanography, University of Washington
Department of Education, University of Washington
Department of Natural Resources, King County, Washington
Department of Ecology, State of Washington
Puget Sound Naval Shipyard, Bremerton WA
Ocean Inquiry Project, Seattle WA

Award Made: FY 2000

OBJECTIVES

We are a partnership of university departments, local, state, and national government agencies, and a non-profit educational organization, which all share a concern for the marine environment of Puget Sound, Washington. Puget Sound is the southernmost fjord on the west coast of North America and the largest such body of water in the coterminous forty-eight states. The Seattle-Tacoma-Everett metropolitan area is located on its eastern shore. The region is experiencing one of the fastest urban growth in this country, and Puget Sound and its marine ecosystem are feeling the stress of this growth in many forms such as wastewater discharge, habitat modification and destruction, and possibly excessive fishing and harvesting of commercial species. Our scientific knowledge of this remarkable estuarine system is as yet quite limited and not up to the task of guiding our effort to preserve the Sound's marine environment. The listing of Puget Sound's salmonid population under the Endangered Species Act has put an additional urgency on our need.

Our partner members realize that, in order to develop the understanding we need, we must work together as a community as well as each institution putting the best effort it can muster. Several of us have independently developed or are developing computer models of water circulation, either for the entire sound or its sub-regions, in response to particular missions and needs of the organization. We also have two educational partners working on opposite ends of the spectrum of activities: one,

providing an opportunity for young people to experience the sea and its science while collecting scientifically meaningful data; and the other, making the model results more accessible and understandable to students and lay people. Here is a potential for a genuine community of modelers connected to the broader oceanographic community and to the needs of the regional community as a whole. The purpose of our partnership is to capitalize on this potential and form a “node” of estuarine circulation modeling based on our existing and forthcoming capabilities, to support each other’s modeling efforts through shared expertise, data and resources, and to make these available to members of the local and national community who are themselves interested in estuarine modeling.

ACCOMPLISHMENTS TO DATE

Since the inception of our partnership we have held regular meetings to exchange views and develop the work plan. The original members have been joined by Puget Sound Naval Shipyard (PSNS) and Ocean Inquiry Project (OIP). The shipyard is located in Bremerton, WA, on Sinclair Inlet which branches off the Main Basin of Puget Sound. They have a strong concern for the environment of Sinclair and Dyes Inlets, and have developed and successfully calibrated a three-dimensional circulation model of the Sinclair-Dyes system. OIP is a recently formed, innovative non-profit group aimed at providing educational experience to K-12 students through seagoing and data-gathering activities, the latter with professional quality control. We hope to develop a new kind of data stream through OIP, which would benefit not only our modeling effort but also the region’s oceanographic community as a whole. A noteworthy element of the Project is its partnership with Seattle Maritime Academy, whose training cruises will provide low-cost ships of opportunity for education and science in local waters.

University of Washington’s circulation model of the entire Puget Sound circulation has been adopted by King County Department of Natural Resources for a siting study for a proposed wastewater treatment plant and its marine outfall. The model is now being calibrated and verified with current data from the observational component of the siting study. Initial comparisons with current meters at fixed locations and with paths of drifters moving with the water have been very promising. We have also developed specifications for a comprehensive marine ecosystem model appropriate for Puget Sound. Currently the model is being coded as an interactive module that can interface with a variety of circulation models.

We have also considered how our partnership can serve the need of the regional community, and we conducted a web-based “users needs analysis” during the summer of 2000. A survey form was posted to a web site and members of the marine community in Puget Sound region were invited to indicate their current and planned data-gathering and modeling activities and needs. We received twenty-six responses from diverse respondents representing state, federal, county and tribal agencies, as well as nonprofit and for-profit private sectors. Half of the respondents indicated that they were directly responsible for resource management decisions, and that “management” and “education” were the primary mission of their organization. A little over half of the respondents collect data related to water temperature/salinity, habitat, and some form of water chemistry. Of great interest to us was the fact that while a majority of respondents indicated that computer-based modeling would be of benefit to them, many said they were hampered from entering this area due to a lack of skilled staff and appropriate data. This indicates to us that efforts to make our expertise available to the people in these organizations and to train them would be greatly appreciated in the regional community. A regularly held, regional modeling workshop could be a part of the planned partnership activity.

ANTICIPATED RESULTS

We are currently working on a five-year partnership plan that we will submit to NOPP at the end of April 2001 in response to 2001 Broad Agency Announcement. We believe the title of Topic D of BAA, "A Commons for Ocean Information", describes the character and the mission of our partnership quite accurately, and we hope to prove this in our work plan.

TITLE: Gulf of Maine Biogeographic Information System (GMBIS)

Dale A. Kiefer, Department of Biological Sciences, University of Southern California

3616 Trousdale Parkway, Los Angeles, CA 90089-0371

Phone: 213-7405814 Fax: 213-7408123 Email: kiefer@usc.edu

Project Partners:

University of Southern California (USC, Los Angeles)

Bedford Institute of Oceanography (BIO, Halifax)

Atlantic Reference Center (ARC, St. Andrews)

Award Made: FY 2000

OVERVIEW OF GMBIS

Central to the development of an inventory of marine life and improved conceptual understanding of the mechanisms shaping species distribution patterns is the implementation of strategies aimed at enhancing assimilation and access to existing biogeographical information. The *Gulf of Maine Biogeographic Information System* project (GMBIS) is a joint initiative of the University of Southern California (USC, Los Angeles), Bedford Institute of Oceanography (BIO, Halifax) and the Atlantic Reference Center (ARC, St. Andrews) that has been funded for 2 years by NOPP under its "Census of Marine Life" program. Our objective is to provide a framework for the integration, visualization, analysis and dissemination of diverse types of biogeographical and oceanographic information. End-to-end viability of this approach is demonstrated in the context of a pilot application for the Gulf of Maine, a well-studied ecosystem for which extensive scientific data exists but one that historically has been subject to large-scale perturbation due to overharvesting. The project will be a proof-of-concept activity to explore how a geographical information system (GIS), internet and database technologies can be used to access and display integrated data products needed to address questions relating to the dynamics of species distribution patterns within the Gulf of Maine. Databases at the core of the information system include those of BIO, ARC and the North East Fisheries Science Center (NEFSC) at Woods Hole, which are the product of US and Canadian multidisciplinary research efforts over the last 30 years in the region. The development of GMBIS may serve not only as a model for the global Ocean Biogeographical Information System (OBIS), but it may also provide a powerful tool in support of new international and national demands for integrated, and ecologically responsible approaches to marine resource management.

GMBIS PROJECT ACTIVITIES

The following provides a complete breakdown and summary of activities undertaken thus far for the Gulf of Maine Biogeographical Information System (GMBIS) project. From this it will be seen that considerable progress has been made in several areas: refinement of the GMBIS concept to better support potential future requirements of OBIS; project administration and in particular the

establishment of a chain of command/responsibility and allocation of specific programmatic tasks; communication of the GMBIS concept and project objectives and development of medium for monitoring of project status; EASy/Netviewer software enhancements and GIS application development from the GMBIS project.

Project Administration

- Oversee and help resolve contractual problems pertaining to the submission of sub-contracts by DFO Maritimes Bedford Institute of Oceanography and the Atlantic Reference to the University of Southern California as collaborators and contributors to the GMBIS project. Although delaying full-scale collaborative efforts, considerable progress was still made under the circumstances both in terms of detailed thematic direction of the GMBIS project and on issues of data exchange.

Meetings

Project Kick-off meeting (BIO, Halifax, 8/8-11/00)

- Review OBIS/GMBIS objectives

- Discuss GMBIS project management, scheduling & contractual matters

- Meet collaborators (BIO/ARC) & identify their specific needs for and contributions to GMBIS

- Review of datasets

- Identification of scientific themes around which data selection and info system development will proceed

NOPP “Census of Marine Life” Program Participant Meeting (URI, Narrangasset, 9/12-13/00)

- Review and discuss OBIS concept, meet other PI’s and introduce pilot projects.

- Attended by Kiefer & Branton for USC & BIO

NEFSC Meeting (NEFSC, Woods Hole, 9/14/00)

- Discuss collaboration and access to NEFSC data for GMBIS.

University of Maine Meeting (Dept. Oceanography, Univ. Maine, Orono, 11/21/00)

- Demonstration of GMBIS GIS project in EASy and Netviewer to GoMOOS team.

Communications

Paper submitted and published in special edition of *Oceanography* dedicated to “Census of Marine Life” initiative: Tsontos, V.M. & D.A Kiefer. (2000) Development of a Dynamic Biogeographic Information System for the Gulf of Maine, *Oceanography* 13(3), 25-30. (PDF download from <http://netviewer.usc.edu/web/main4.html>)

Development of GMBIS project Website (<http://netviewer.usc.edu/web/>)

- Aims: convey general information about the project, facilitate communications among participants, serve as a hub for reviewing project schedules and progress, and function as a repository of project data products and literature.

- Netviewer integrated and allowing interactive viewing of GMBIS data via EASy GIS.

GMBIS GIS Application Development in EASy

Extraction and ingestion into EASy of coastline/bathymetry data for the study area from the following sources: USGS coastline data, GEBCO 97 world coastline/bathymetry atlas. Routines developed for extraction of high resolution bathymetry/altimetry data for the study area from the “Sandwell Dataset” for possible future ingestion into EASy.

Agreement on data format standards and resolution of format incompatibilities for satellite imagery. Provision and ingestion into EASy of full time series of bi-weekly satellite ocean color and thermal imagery for the period Sept. 1997 to Sept 2000.

Provision and implementation within EASy of quantitative relationships between pixel values and measurement values for SST and Chl-A satellite imagery.

Creation of database for documenting and holding supplied data products prior to transfer and ingestion into EASy project database.

Provision and ingestion into EASy of sample physical data products (in ASCII format) relating to large-scale and climatological characterizations of the Gulf of Maine and Scotian shelf (themes 1a & 1b). Model and field data types ingested include residual vector flow fields and temperature, salinity and density mean field descriptions.

Provision of sample Scallop by-catch survey data (as Excel files), resolution of ambiguities, and transfer to holding database for future ingestion into project database.

Creation of EASy project database for GMBIS and associated project files defining data variables and associated plotting parameters.

EASy Software Development for GMBIS (SSA)

Development of capability to ingest and display USGS coastline datasets available in ASCII format. Modification of existing routines to robustly ingest coastline/bathymetry datasets in Autocad DXF format for the study area from the GEBCO atlas.

Adapt imagery ingestion routines to deal with particular binary and HDF formats for satellite imagery used by BIO for their supplied data products.

Development of capability for EASy to display georeferenced data in MERCATOR projection in addition to existing LAMBERT projection mode.

Development of capability to ingest, graphically render, and archive as imagery extensive model flow field vector datasets provided in a custom ASCII format.

Development of ASCII file "Import Wizard": facilitates the ingestion of datasets from ASCII files of varying format into the project ACCESS database in accordance to the specific database structure required by EASy.

Development of capability to capture and replay all graphically rendered database and computed imagery so as to speed up data visualization during project simulation and Internet data transfer.

Update of the NETVIEWER Internet client-server plug-in/service for EASy. All GIS applications developed with EASy desktop can now be interactively accessed and displayed across the Web by simple installation of the Netviewer service DLL. The GMBIS project application is web-enabled and can be viewed at: <http://netviewer.usc.edu/web/output.html>

Development of interactive tools and graphical user interfaces for the user-friendly definition of project configuration parameters in EASy (eg. Data sources, data variables and associated plot types, simulation time steps, contouring and other computational parameters, etc).

Software testing: EASy and Netviewer.

TITLE: Development and Verification of a Comprehensive Community Model for Physical Processes in the Nearshore Ocean

James T. Kirby, Center for Applied Coastal Research, University of Delaware

Newark, DE 19716 Phone: (302) 831-2438 fax: (302) 831-1228 email: kirby@udel.edu

Project Partners:

John Allen, Oregon State University

Tom Drake, North Carolina State University

Steve Elgar, Woods Hole Oceanographic Institution;

Robert T. Guza, Scripps Institution of Oceanography
Dan Hanes, University of Florida
Tom Herbers and Edward B. Thornton, Naval Postgraduate School
Jim Kaihatu, Naval Research Laboratory, Stennis, MS
George Mellor, Princeton University
H. Tubazkan-Haller, University of Michigan
Ib A. Svendsen, University of Delaware

Project Web Address: <http://chinacat.coastal.udel.edu/~kirby/NOPP/>

Award Made: FY 1999

PROJECT OBJECTIVES

Our goal is to develop a comprehensive, verified community model that predicts nearshore hydrodynamics, sediment transport, and seabed morphology changes given offshore wave conditions and initial bathymetry. We are utilizing a framework where wave processes are distinguished from wave-averaged processes by means of a suitable time average. A model system consisting of a tightly coupled set of process modules is under development. The resulting set of modules and their functions are:

1. wave module - calculation of second- and third-moment wave properties, including frequency-directional spectra, radiation stresses, and wave skewness and asymmetry
2. circulation module - calculation of wave-driven circulation and turbulence levels
3. seabed module - calculation of local sediment fluxes and seabed changes resulting from flux divergences, and characterization of bed geometry

A model backbone will allow interaction and feedback between the individual modules, as well as provide an interface to users. Candidate models to be used within each module are being investigated and tested. The model backbone will be constructed as an open architecture with a documented set of required inputs and outputs for each component, allowing users to provide alternative formulations for each module.

ACTIVITIES/ACCOMPLISHMENTS TO DATE

Two meetings have been held to organize activities and review results. Working groups have been formed in the areas of (1) surface wave dynamics, (2) wave-induced circulation and turbulence, (3) sediment transport and seabed morphology, and (4) verification and data assimilation. Groups (1)-(3) are pursuing the development and testing of individual modules with the goal of advancing the science in each, as well as defining how each module will interact most effectively with the other model components. Group (4) is testing and calibrating existing models, and assembling a WWW site for field data that can be used by the NOPP partners to test individual modules.

The SHORECIRC model, which is being developed as one candidate circulation module, has been documented and released to project personnel in advance of a general public release. A reformulation of the model in terms of the total depth-averaged Eulerian velocity has produced a much more stable numerical code, which is now being used to investigate the three dimensional structure of rip currents. Extensions of the model to incorporate random wave forcing and a curvilinear grid in horizontal coordinates are nearly complete.

The Princeton Ocean Model (POM), which serves as a second candidate circulation module, has been adapted for applications to wave-averaged circulation by adding parameterized forcing represented by gradients in the radiation stress tensor. Additional forcing related to wave rollers also is included. Initial studies have focussed on alongshore-uniform flows with spatial variations in the cross-shore and vertical directions. Different turbulence closure models are being tested, along with different boundary conditions for the turbulence quantities at the surface. An efficient wave-current bottom boundary layer sub-model that parameterizes the influence of the waves on the bottom stress has been embedded in POM. The model has been applied to studies of the circulation off Duck, NC and model results are being compared with velocity measurements from the DUCK94 field experiment. Reasonable agreement has been found between the model and measured velocities. The effects of tidal elevation change on the circulation are investigated and show, in particular, variations in the strength of the undertow over the bar and in the trough with tidal height that are in general agreement with velocity measurements from the fixed array.

Work on sediment transport modeling has concentrated on numerical prediction of bedload transport. A direct simulation of granular motion and fluid-grain interaction has been extended to include the effect of bed slope and wave-induced velocity and pressure gradient time histories. Results from these simulations are being parameterized to provide improved wave-averaged transport formulations. Investigation of observed sand bar migration, waves, and currents suggests that coupling and feedback between morphology, shoaling waves, and wave orbital velocities and accelerations result in landward bar migration when mean currents are weak. These results indicate that fluid acceleration, usually neglected in sediment transport models, may be an important component in sediment transport. This result is supported by the discrete particle simulations for the case of asymmetric broken waves, which also show the importance of fluid acceleration. Results of the discrete particle simulations will be used to develop wave-averaged transport formulations for use in SHORECIRC and POM.

Results from previous field experiments have been collected and made available for model testing by means of a password protected web page located at <http://science.whoi.edu/NOPP/NOPPmain/main.html>. Data from the Duck 94/CoOP experiment and a surfzone deployment near the Scripps pier are presently online.

IMPACT

The model system under development will provide a comprehensive predictive tool for nearshore processes, and will have a wide range of uses in the scientific community, as well as in DoD and civil planning and operations.

Title: Expansion of CephBase as a Biological Prototype for OBIS
Phillip G. Lee, University of Texas Medical Branch, Galveston, TX

Project Partners:

Project Manager: James B Wood, University of Texas Medical Branch, Galveston, TX

Co-Principal Investigator: Ron K O'Dor, Dalhousie University, Canada

Collaborator: Mike Vecchione, Smithsonian Institution's National Museum of Natural History, Washington, DC

Award Made: FY 2000

PROJECT OBJECTIVE

CephBase is a dynamic html relational database-driven interactive web page (www.cephbase.dal.ca). The research objective is to design, implement and operate a relational database focusing on all aspects of cephalopod biology, taxonomy, ecology, life history, physiology and behavior in a mode that is intuitively useful to a wide range of users from the novice to the expert.

ACTIVITIES/ACCOMPLISHMENTS

The CephBase team has spent most of the fall of 2000 ordering computers, ordering and installing new software, hiring student assistants, developing protocols, attending organizational meetings, preparing data for the database and taking advanced computer training classes.

Training has been a major objective in this time period as specified in the proposal. Mr. Chris Zuercher, our UTMB hardware and systems administrator, has been busy taking course and studying for Microsoft Network Administrator certification needed to upgrade CephBase on the network. Dr. James Wood has attended the Allaire Fast Track to Cold Fusion training course and is overseeing the day-to-day administration of CephBase.

A powerful new Dell server was acquired and is running NT 4.0. We are in the process of installing Cold Fusion 4.6 server on the server, upgrading CephBase from Cold Fusion 3.1 to 4.6, upgrading CephBase from Access 97 to Access 2000 and moving it physically to our this new UTMB server.

As outlined in our grant proposal, we have a unique in-house collection of images of cephalopods. Two part time student assistants have been hired. Images of live cephalopods are very important, as the many species-specific color, texture and shape patterns of cephalopods are lost upon preservation. One of our student assistants, Ms. Jennifer Robinson, is scanning our extensive collection of 35 mm slides for incorporation into CephBase. We now have more than 300 images scanned and stored. I expect these pieces (images, references, new url, etc) to start coming together on the web site by March of 2001.

In addition to our images, we have an in-house library that contains approximately 4,000 references on cephalopods. Much of the information is already in a digital form. The second student helper, Ms. Judy Gocke, is formatting these references so that they can also be added to CephBase. She has also successfully developed protocols for converting EndNote (a reference database) files to MS Access and back. We currently have about half of the references ready to be added to CephBase.

Our Canadian collaborators have also been busy. Catriona Day, Dalhousie University, is scheduled to take the Cold Fusion course early in 2001. Ms. Day has also been working on streamlining and updating the International Directory of Cephalopod Workers in the current version of CephBase. A spin off project and additional matching funds from the CephBase project is being seriously considered by the Biology Department at Dalhousie University. They are considering purchasing their own server and mirroring CephBase as well as using CephBase to encourage other biological database initiatives at the university.

We have been communicating with our Smithsonian partner and trying to get a student hired to assist Dr. Vecchione. We anticipate that this will be accomplished soon and Dr. Lee has scheduled a March meeting with the Smithsonian staff to coordinate the activities there.

We are also working with a colleague in Japan to add an additional thousand references from his EndNote database. Dr. Wood is continuing to correspond with colleagues in order to incorporate additional types of data into the database. Dr. Allcock at the National Museum in Scotland is putting together a local database identifying cephalopod by their beaks and we have offered to support this database as part of CephBase. We are continuing to investigate dynamic online mapping options. Our Oceanography manuscript on CephBase has been published and many colleagues have already requested reprints.

ANTICIPATE RESULTS/IMPACT

After two years, CephBase users will be able to click on a species of cephalopod and not only have access to the full taxonomy, but they will also have access to a library of images and video that show the unique features of the species; maps of the species range; relevant temperature, bottom type and other environmental variables on distribution maps; an extensive list of predators and prey complete with links to other databases; life history data for many species of cephalopods and a searchable list of references. Furthermore, there will be educational articles illustrated with animation, images and video clips on topics such as: how squids jet through the water, how chromatophores work, why octopuses have three hearts and more.

Teachers, public aquariums and students will have on-line support for dissections, cephalopod identification, along with interesting and engaging pages about the life history, behavior and physiology of cephalopods. Cephalopods are important commercially and our site will have data such as growth rates, fecundity, distribution and life cycles that is critical for government stock management. Fishermen will use the site to identify new species and biogeographical parameters that help them locate good fishing grounds.

TITLE: Limited Area Coastal Ocean Models: Assimilation of Observations from Fixed Platforms on the Continental Shelf and Far-Field Forcing from Open Ocean Models Dr. Daniel Lynch, Dartmouth College

Project Partners:

- Dartmouth College - Real-time data assimilation theory and implementation; OSSE organization
- University of North Carolina - Implementation of SAB model operational system; assimilation of GODAE products and atmospheric products
- Woods Hole Oceanographic Institution - Ocean color assimilation and inversion
- Skidaway Institute of Oceanography - Liaison with SABSOON
- National Oceanic and Atmospheric Administration
- National Weather Service, Jacksonville and Charleston - Hi-resolution MET forecasts; sea surface forecast products
- North Carolina Supercomputing Center - Software engineering for advanced computing platforms, forecast archive and archival services

Award Made: FY 2000

PROJECT DESCRIPTION:

The objective of this project is to build an operational system for site-specific, limited-area forecasting of the coastal ocean. The system will be applied and tested in the South Atlantic Bight; it will be modular and portable to other waters. It will feature coupled physical/biological phenomena in and around the South Atlantic Bight Synoptic Offshore Observational Network (SABSOON). In-situ and remotely sensed observations will be assimilated, plus results from atmospheric and global ocean models. The atmospheric products will be handled within the partnership; the remotely-sensed data will be obtained from standard sources; and the oceanic products via cooperation with the Global Ocean Data Assimilation Experiments (GODAE). SABSOON will be the primary source of in-situ data.

Workshops will be conducted with the observational community using Observational System Simulation Experiments (OSSE's) to develop effective sampling and assimilation strategies. Operational nowcasts/forecasts will be provided for water level, currents, and hydrography, sufficient to support scientific and commercial interests. Procedures for assimilation and model-based interpretation of ocean color data will be developed and evaluated.

The fundamental problem to be solved is the valid interpretation of physical and biological observations, using data-assimilative models for scientific interference, for forecasting, and for design of operational sampling programs. The project will lead to fundamental progress in understanding key aspects of the shelf-ocean-atmosphere coupling, as presented in the South Atlantic Bight. This partnership will advance the state of the art in formal data assimilation methods for this dynamic regime. In addition, it will generate community-based software for operational shelf forecasting.

TITLE: Application of an Integrated Monitoring and Modeling System to Narragansett Bay and Adjacent Waters incorporating Internet-Based-Technology

Dr. Michael Piasecki, Drexel University

Dr. Malcolm Spaulding, University of Rhode Island

Project Partners:

Dr. Craig Swanson, Applied Science Associates Inc.

Dr. John Kelley, NOAA, NOS and ARL

Dr. John Mustard, Brown University

Award Made: FY 2000

OBJECTIVES

1. To develop and implement an operational three-dimensional hydrodynamic and pollutant transport model, with data assimilation, for Narragansett Bay and adjacent Rhode Island coastal waters. The application will demonstrate the ability of the models to provide hindcasts, nowcasts, and forecasts and maximize the timely and effective use of GODAE data products. The model will use GODAE data products for forcing on the open boundary and hence extend this data to coastal and estuarine waters.

2. To coordinate the collection, dissemination and archiving of observed sea surface elevation, water quality, meteorological, and current and water transport data from a network of monitoring stations in Narragansett Bay and adjoining waters including global ocean data products generated through the
3. GODAE initiative and other sources. This objective will be accomplished through the development of a platform independent internet based data and model product data distribution system that will allow industry, researchers, government, and public to conveniently access all relevant data from the local monitoring system, GODAE and all model simulation results.
4. To assess the market for the GODAE, high resolution coastal model, and observational data products and services for Narragansett Bay and to determine the most efficient and cost effective mechanisms to distribute the data to the clients and user community.
5. To transfer the technology and software for the system to private industry as a basis to develop a commercial market for a globally re-locatable, fully operational monitoring, modeling and data distribution system. The technology transfer is intended to establish a commercial basis so that data products

ACTIVITIES/ACCOMPLISHMENTS TO DATE

Dr. Michael Piasecki, Drexel University:

The first part of the necessary equipment (high end PC operating under LINUX) has been ordered, received, and set up. The project web-page has been developed and published for general access. This site is intended to serve as clearing house for project related information among the partners as well as to inform a wider audience. A password-restricted section will be used by the Drexel research team to distribute and disseminate research results.

A general "data-request" survey has been developed, which will be distributed among a large group of potential users in the region. This group includes commercial, governmental, and private sector interest groups. It is anticipated that this survey will be sent out in the first quarter of 2001 and, when returned, help to develop a better understanding of the user data needs.

Drexel has received extensive subsets of ocean and meteorological from the research group at URI. These sets will be used to develop the necessary web-based visualization and analysis tools. Additionally, first steps have been taken to discuss internal data storage and access logistics that are an integral part of how COASTMAP, as the central data clearing house, and the web-based tools will communicate and transmit data requests.

Dr. Malcolm Spaulding, University of Rhode Island:

COASTMAP has been set up and is currently operational for Narragansett Bay, its watershed and adjacent coastal waters including RI Sound, Block Island Sound, and Buzzards Bay. Key geographic data sets (rivers, streams, highways and roads, railroads, etc.) have been obtained from the RI Geographic Information System and integrated into the system. As currently configured the system provides real time access to the NOAA/NOS Physical Oceanographic Real Time System for Narragansett Bay via the NOAA web site. This data can be presented in terms of the time series of each variable (currents, salinity, temperature, wind speed/direction) at any station or in terms of a summary of the most recent data collected at each station. The data can be contoured to show spatial trends over the bay. Access to the remaining real time sensing systems in Narragansett Bay and the RI Roadway Information System is currently under development.

Real time access to the NOAA/ National Center for Environmental Prediction (NCEP), Coastal Ocean Forecasting System (COFS) predictions for the east coast of the US, and specifically southern New England shelf waters has been established and visualization tools developed to display model predictions. Initial access to output from the Navy's global ocean hydrodynamic model has been established but is currently restricted to historical data.

Dr. Craig Swanson, Applied Science Associates Inc.:

The major effort by ASA has been the preliminary application of BFHYDRO, the three dimensional, boundary fitted hydrodynamic model, to Narragansett Bay and the sounds to the south of the bay. A fine resolution coastline has been generated to provide a base map for use in WQMAP. Bathymetry data has been obtained for the area from NOAA.

A series of model grids have been generated for the area. These grids have cells of different sizes and were designed to resolve features of bay circulation at different levels. The grids have also been used to assess model execution times for eventual running of the model in nowcast and forecast modes.

A series of meetings have been held with URI Ocean Engineering (OE) staff to discuss the data requirements and data file formats for driving the model. The NOAA/ National Center for Environmental Prediction (NCEP) Coastal Ocean Forecasting System (COFS) predictions will be the first linkage made. The effort is focusing on the specification of surface elevation at the model open boundary. Sensitivity of model open boundary location offshore is being investigated.

Discussions have also been undertaken to determine functionality requirements of the ASA hydrodynamic model system and the COASTMAP system being modified by OE. It has been decided that the data display and analysis tools from COASTMAP be modular so that they can easily be inserted in WQMAP for use with model results.

Dr. John Kelley, NOAA (NOS and ARL):

NOAA's National Ocean Service and Air Resources Laboratory advertised for a UCAR visiting postdoctoral scientist in numerical weather prediction to assist their meteorologists in implementing the new Weather Research and Forecasting (WRF) model. WRF will serve as the forecast component of the Local Analysis and Prediction System (LAPS) for the Narragansett Bay watershed. Seven applicants applied for the position and NOS has begun interviewing the top three candidates.

The beta version of WRF was released on Dec. 20th and NOS has download a copy of the model to their SGI Origin 2000 computer. NOS is also working with a local National Weather Service Weather Forecast Office to obtain routinely hourly weather observations from the Automated Weather Source, Inc. network stations in southern New England. These observations would be used for verification of LAPS analyses and forecasts.

NOS has not received their NOPP funds for the 1st year, but is working with Drexel University research office to have the funds transferred from Drexel to UCAR to pay for the NOS postdoc position. Next year, this delay will be avoided by having a direct transfer of funds from NASA to NOS.

Dr. John Mustard, Brown University

Brown University's activities will not start until the second year of the project.

TITLE: Models of the Coastal Ocean off the West Coast of North America: A Comparative Study and Synthesis of Observations

Dr. Thomas Powell, University of California, Berkeley

Project Partners:

- University of California Berkeley - Overall leadership; meeting organization and logistics (travel arrangements); work-plan and final NOPP proposal preparation (lead role); aid to small computer users (e.g. front end to "hub" connections)
- University of California Los Angeles - Overall leadership; meeting organization; work-plan and final NOPP proposal preparation; computing support, especially devoted to remote computing at large facilities (e.g. accounts, evaluation of procedures, etc.); preparation of report on "hub" emulation experiences
- Oregon State University - Overall leadership; meeting organization; work-plan and final NOPP proposal preparation
- Naval Postgraduate School - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- Rutgers, The State University of New Jersey - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- Scripps Institution of Oceanography - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- Jet Propulsion Laboratory - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- Naval Research Laboratory - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- National Oceanic and Atmospheric Administration/Pacific Fisheries Environmental Group - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- National Oceanic and Atmospheric Administration/Pacific Marine Environmental Laboratory - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- Institute of Ocean Sciences - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation
- National Center for Atmospheric Research - Meeting and task-group participation, including computational projects, as appropriate; work-plan and NOPP proposal preparation

Award Made: FY 1999

PROJECT DESCRIPTION:

The partnership will conduct a year-long planning activity to develop a concrete, detailed work-plan that will concentrate and strengthen modeling and data assimilation off the Pacific coast of North America. The overall goal of the partnership is to develop a coherent and comprehensive picture of the ocean processes in this coastal region of the eastern Pacific. Moreover, the techniques of data

assimilation are becoming sufficiently well-developed that a synthesis of data and models is within reach of investigators.

TITLE: A Biotic Database of Indo-Pacific Marine Mollusks
Gary Rosenberg, Academy of Natural Sciences, Philadelphia

Project Partners:

Dr. Winston Ponder, Australian Museum, Sydney

Dr. Philippe Bouchet, Museum national d'Histoire naturelle, Paris

Dr. Terrence Gosliner, California Academy of Sciences, San Francisco

Award Made: FY 2000

PROJECT OBJECTIVES

We propose to create a biotic database of the estimated 35,000 named species of mollusks in the Indo-Pacific region. The database will include the fields required by the international standards of Species 2000 for global species databases, which treat the current classification and synonymy of each species. It will also include summary data on the distribution and ecology of each species, as available in the scientific literature. Point data for more than 200,000 specimen records of mollusks in the collections at the Academy of Natural Sciences, the Australian Museum and the California Academy of Sciences will be included. Another objective is to combine Indo-Pacific data with existing species databases for Western Atlantic and Europe marine mollusks and for higher taxa of mollusks to form the basis of a global database of mollusks.

ACTIVITIES/ACCOMPLISHMENTS TO DATE

- 1) A Task Manager was developed in July that allows all project participants to view, on the World Wide Web, who has been assigned to what task, what tasks have been completed, and which are ongoing. This prevents duplication of effort.
- 2) The principles of the project met in Philadelphia in August. At that time we developed a standard vocabulary for recording ecological and biological information in the database. We also agreed on explicit conventions for data entry and protocols for backing up data and sharing it across the Internet.
- 3) Existing Indo-Pacific from Platypus and Western Atlantic data from Paradox were imported into BioLink. Importing bibliographic data from Platypus to BioLink was complicated because Platypus is not case-sensitive and BioLink is. This problem has now been fixed. All generic names in BioLink have been cross-checked against the database in Paris and all discrepancies have been resolved.
- 4) The principals met in Sydney, Australia in December to discuss overall progress and determine if there were any quality control issues. The overall rate of data entry is approximately what was estimated in the grant proposal (15 species per person per day), however, we are entering major works first, so this rate will probably slow as we hit more scattered literature. To compensate for this, we have requested some modifications from the developers of BioLink that will allow more efficient data entry. The main quality control issue is that some data outside the scope of the project

have been entered (on fossil species), but this does not impact the usability of the database. This is no longer a problem as the data entry personnel have more experience now.

ANTICIPATED RESULTS/IMPACT

The product database will provide a uniform framework for linking specimen records from worldwide museum collections and also data from molluscan fisheries to show spatial and temporal patterns of occurrence and abundance. It will provide on-demand information via the Internet about any species in question, as well as lists of species restricted by geography, taxonomy, bathymetry or ecology. As such it will be an invaluable tool for scientists and environmental managers, as well as students, amateur biologists and naturalists.

TITLE: PARADIGM: The Partnership for Advancing Interdisciplinary Global Modeling Lewis M. Rothstein, Graduate School of Oceanography, University of Rhode Island

Project Partners:

Oregon State

University of Miami

Virginia Institute of Marine Science

Massachusetts Institute of Technology

Rutgers, The State University of New Jersey

Old Dominion University

Woods Hole Oceanographic Institution

Naval Research Laboratory

National Oceanic and Atmospheric Administration

National Aeronautics and Space Administration

National Center for Atmospheric Research

Award Made: FY 1999

PROGRAM OVERVIEW

Advances in modeling of marine ecosystems will come through the development of interlinking circulation, ecosystem and optical models that are in turn interfaced with a wide range of measurement systems. Accordingly, the overall administrative objective of our consortium is to assemble the necessary multidisciplinary expertise and to develop the community infrastructure that will allow data assimilative, coupled physical-biological ecosystem models, with embedded biogeochemical components, to be developed and implemented for a wide range of marine environments. We will develop an efficient, community-based modeling framework that will make transparent the addition of new oceanographic processes suggested by our own and the larger community's research. Moreover, this framework will allow new model structures to be developed and explored as our understanding of ocean ecology and biogeochemistry improves. Our modeling framework will be designed to expose, through the use of well-defined, open interfaces, the critical assumptions and methods employed in formulating new integrated models of ocean systems.

This modeling framework will be developed within the context of a specific scientific focus on an inter-comparison study between the subtropical-subpolar gyre systems of the North Pacific and North Atlantic basins. Our particular emphasis is on understanding large-scale changes in plankton

community structure and biogeochemical cycling, including the shifting paradigms for ecosystem control that are driven by long-term changes in the ocean-atmosphere circulation. Our basin-scale programs necessarily include both North Atlantic and North Pacific coastal research programs. These models must include adequate representations of physiological and ecological processes and their linkages with the physical environment in order to understand and predict how systems will change in both structure and function within the context of ocean biogeochemistry. Simple models based on equilibrium/bulk assumptions will not work. However, simply adding more and more undefined (and often unmeasurable) components and processes will not work either. Substitution of a complicated model we cannot understand for the complexity of the poorly understood real world is not progress. Our effort will require regional, basin-scale and global modeling efforts with a strong component of retrospective analysis as well as data assimilation. Close collaboration with new field studies and observational infrastructure will also be required, as the models will likely elucidate the needs for better sampling or better estimates of critical processes.

The comparative, basin-scale focus frames our primary scientific objective which is to improve our understanding of the mean state, seasonal cycle, and natural inter-annual to decadal variability of these basin-scale biogeographical patterns. Why do different ecosystems reside where they do? What combination of forcing and biological responses drives the observed long-term variability and apparent ecosystem regime shifts? The characteristic scales of ocean ecology are set by the growth and removal of phytoplankton, with time-constants of one to a few days, and spatial scales of 10's of km. Our program scope must therefore encompass the range of coupled dynamics of ocean ecology, biogeochemistry, and physics on time/space scales from sub-diurnal to multi-decadal and submesoscale to global. The complexity and heterogeneity of this system suggests that observations by themselves will not be sufficient for understanding. Comprehensive coupled models are the most powerful tool available to analyze such vast and varied biogeochemical systems, integrating the myriad of heterogeneous forcings, processes and observations in a way that will lead to a greater understanding and predictive capability at the system level. Clearly, a comprehensive and coordinated numerical modeling and data analysis effort is required.

Our program is divided into four major scientific themes or questions:

- What factors govern phytoplankton biomass, productivity and export, the net remineralization of organic matter below the euphotic zone, and the spatial (e.g. biogeographical regimes) and temporal (e.g. climate regime shifts) variations in these global processes? Field studies from the JGOFS era demonstrate quite clearly for particular locations and times the critical roles of multiple limiting nutrients (e.g. iron), grazing, trophic/community structure, and physical variability. Less well-constrained are potential, top-down controls (e.g., effects of overfishing) and the interactions amongst all these processes.
- What governs plankton community structure and function and how do they influence biogeochemical fluxes and exchanges in the ocean system? JGOFS and other studies strongly support a two-state ocean model, with a near-uniform background recycling system dominated by small-celled microbial plankton, and a highly episodic and variable component of larger cells (diatoms, mesozooplankton, gelatinous plankton) which contributes most of the export. From a biogeochemical perspective, the activity of key planktonic functional groups (nitrogen fixers, calcifiers, bacteria and large grazers, etc.) is also important. Moreover the structure of the community may remain unchanging while its biogeochemical functioning varies.

- How do sub-mesoscale and mesoscale physical variability impact ecosystem fluxes and community structure? Mesoscale variability and disturbance are fundamental aspects of the marine system, not simply noise. The scientific details of how transient behavior rectifies into large-scale or long-term variability are not well known and more observations are required. Present computational constraints also prohibit full numerical resolution of all scales of interest, requiring technical advances in grid-nesting, heterogeneous and adaptive grids and subgrid-scale parameterizations.
- How do we best merge observations and models? Biogeochemical and ecosystem models are at their core data driven, or from another perspective, models are powerful tools to analyze the behavior and dynamics of complex systems such as marine ecosystems. Unlike ocean physics, we do not have a Navier-Stokes law for biology. But we do have strong ‘first principles’ constraints, e.g. allometric size vs. respiration relationships, nutrient limitation and stoichiometric controls, etc. Further, the quantity and complexity of model output and observational data are increasing dramatically. Progress will require new statistical data analysis techniques, more sophisticated use of data visualization, rigorous model-data evaluation, and greater reliance on data assimilation.

These four major scientific themes will be addressed through a series of six crosscutting program research activities in the areas of:

- ecosystem model development;
- high resolution basin-scale and process modeling;
- development of numerical methods (including data assimilation techniques and nested grid development);
- data synthesis, assimilation and validation,
- focus sites (i.e. regional “test beds”); and
- community global ocean ecosystem-biogeochemistry modeling (i.e. model codes that are global in extent and which are shared amongst the entire research community).

These activities will serve as the framework for our interdisciplinary and collaborative research and will be the basis for development of the next generation of coupled circulation and ecological/biological models for oceanic systems. We stress that these research activities are not independent programs, but rather are integrators across our four scientific themes. Descriptions of each program activity are expanded upon in the proposal.

This is all clearly a task for an interdisciplinary alliance with expertise in biological, chemical, physical and optical oceanography, modeling techniques, and the management and presentation of large amounts of information. Capabilities are changing rapidly in ocean observation and modeling, and the scope of the task before us is too great to be addressed in isolation. The field is moving too rapidly and on so many different frontiers as to make it impossible for an individual or small group to make best use of the work of others. For example, those who construct coupled biological-physical ecosystem models cannot keep up with the latest advances in microbial ecology, parameterization of turbulent fluxes, bio-optical oceanography, in addition to new data assimilation and adaptive-grid numerical techniques. In turn, experimental ecologists are seldom equipped to evaluate critically the results of a circulation model with embedded biology. The path to advancement will be found through the development of effective means for interaction among teams of experts. Common language based on interactive visualization of results and accessible modeling

tools, and developed through personal interactions between experts in a range of disciplines, may be the key. The National Ocean Partnership Program recognized the need for such a partnership and we responded. Our PARADIGM team has come together during more than a year of consultation. Its members have strongly developed individual research programs, and they possess complementary skills and interests and share common goals with a commitment to productive collaboration. Our program represents a natural progression in each of the members' research. As a move in the right direction, we are proposing to establish a consortium of experts with a common scientific goal and a commitment to reaching it through innovative forms of collaboration. We are excited to join forces on this major challenge.

TITLE: A Consortium For Ocean Circulation And Climate Estimation

Detlef Stammer, Scripps Institution of Oceanography

Physical Oceanography Research Division

La Jolla, CA 93093

phone: (858) 822-3376 fax: (858) 534-9820 email: dstammer@ucsd.edu

Project Partners:

Massachusetts Institute of Technology (J. Marshall, and C. Wunsch),

Jet Propulsion Laboratory (I. Fukumori, L.-L. Fu, T. Lee, D. Menemenlis, and V. Zlotnicki)

Scripps Institution of Oceanography (D. Stammer (PI), R. Davis, P. Niiler).

Award Made: FY 1999

GOALS and OBJECTIVES

The ECCO activities are performed in three groups located at MIT (J. Marshall, and C. Wunsch), JPL (I. Fukumori, L.-L. Fu, T. Lee, D. Menemenlis, and V. Zlotnicki) and SIO (D. Stammer (PI), R. Davis, P. Niiler). Each institution has its own task within the entire approach as described below, covering model development, estimation activities, data preparation and scientific analyses. Our goal is to bring ocean state estimation from its current experimental status to a practical and quasi-operational tool for studying large-scale ocean dynamics, designing observational strategies and examining the ocean's role in climate variability. We will improve the ocean general circulation models upon which assimilation is based, evaluate and improve assimilation techniques, and confront the practical problems of marshaling large data sets and carrying out routine assimilation runs. Our central technical goal is a complete global-scale ocean state estimation over at least the 15 year period 1985-2000 at $\frac{1}{4}$ resolution with a complete error description and regional refinements to support CLIVAR and GODAE needs. We will supplement the global state-estimates with high-resolution regional studies in support of CLIVAR's Basin-wide Extended Climate Studies (BECS) in the North Atlantic and the North Pacific. Our focus is on the state estimation of the global ocean in its entirety combining together into a coherent whole all suitable data sets. Our interest is to draw models and observations together over decades of time to arrive at a complete (i.e., including aspects not directly measured) dynamical description of ocean circulation, such as insights into the natures of climate-related ocean variability, major ocean transport pathways, heat and freshwater flux divergences (similar for tracer and oxygen, silica, nitrate), location and rate of ventilation, and of the ocean's response to atmospheric variability.

ACCOMPLISHMENTS

The ongoing ocean state estimations are based on the MIT GCM (Marshall, et al., 1997) and two parallel optimization efforts: MIT and SIO use the adjoint method (Lagrange multipliers or constrained optimization method), exploiting the Tangent-linear and Adjoint Compiler (TAMC) of Giering and Kaminski, (1997) as described in Marotzke et al. (1999), while JPL's focus is primarily on a reduced state Kalman filter, e.g., Fukumori et al., (1999). Those data assimilation activities can be summarized as finding a rigorous solution of the time-varying model state x over time t that minimizes in a least-squares sense a sum of model-data misfits and deviations from model equations while taking into account the errors in both.

The most outstanding result of the ongoing and continuing work is that we were able to complete a first global ocean state estimation of the time-varying circulation over the 6-year time interval 1992 through 1997. Data employed in that optimization included the absolute and time-varying T/P data from October 1992 through December 1997, SSH anomalies from the ERS-1 and ERS-2 satellites, monthly mean sea-surface temperature data (Reynolds and Smith, 1994), time-varying NCEP reanalysis fluxes of momentum, heat, freshwater, and NSCAT estimates of wind stress errors. Monthly means of the model state are required to remain within assigned bounds of the monthly mean Levitus et al. (1994) climatology. To bring the model into consistency with the observations, the initial potential temperature and salinity (S) fields are modified, as well as the surface forcing fields. Changes in those fields (often referred to as "control" terms) are determined as a best-fit (in a least-squares sense) of the model state to the observations and their uncertainties over the full data period.

ANTICIPATED RESULTS

Now ongoing computations move toward a 6-year estimate of the time-evolving ocean circulation (1992 through 1997) with spatial resolution that uses all major WOCE data sets as constraints, and that has build in a complete mixed layer model (Large et al., 1994) and an eddy parameterization scheme (Gent and McWilliams, 1990). It is anticipated that, in two to three years, the project will be able to address the US CLIVAR and GODAE related objective of depicting the time-evolving ocean state with spatial resolution up to $\frac{1}{4}$ globally and with substantially higher resolution in nested regional approaches which are required for quantitative studies of the ocean circulation. The ECCO results, consisting of model fields and related surface forcing are available to the wide community via internet.

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ECCO PUBLICATIONS

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TITLE: Diel, seasonal, and interannual patterns in zooplankton and micronekton species composition in the subtropical Atlantic

Dr. Deborah Steinberg, Virginia Institute of Marine Science

Project Partners:

Dr. Laurence Madin (co-Principal Investigator), Woods Hole Oceanographic Institution

Dr. James Craddock, Woods Hole Oceanographic Institution

Dr. Lena Markhaseva, Russian Academy of Sciences, Zoological Institute, St. Petersburg

Dr. Frank Ferrari, Smithsonian Institution's National Museum of Natural History

Award Made: FY 2000

PROJECT OBJECTIVES:

Our overall objective is to provide a unique data set for use in the Ocean Biogeographical Information System (OBIS) – over a decade of monthly zooplankton and micronekton species composition data from the Bermuda Atlantic Time-series Study (BATS) site in the Sargasso Sea. Planktonic communities comprise an incredibly wide diversity of organisms that form the basis of marine food webs. The zooplankton and micronekton (larger zooplankton or those capable of increased locomotion) provide a direct link between primary producers (phytoplankton) and higher trophic levels such as fishes, sea birds, and some marine mammals. The Bermuda Atlantic Time-series Study (BATS) is a 13-year, ongoing oceanographic time series situated in the western North Atlantic, 82 km southeast of the island of Bermuda. The BATS program samples the ocean on a monthly basis, a strategy that resolves major seasonal patterns and interannual variability.

Our objectives in more detail are to:

- 1) Complete a multi-species inventory of archived zooplankton and micronekton samples that have been collected at BATS
- 2) Provide high resolution data that covers diel, seasonal, interannual, and decadal time scales
- 3) Provide detailed accompanying data available from BATS cruises (e.g., water column temperature, oxygen, nutrients, plant pigment concentration)
- 4) Format both species and other BATS data for incorporation into the OBIS, using techniques already well developed and in use at BATS for organizing, archiving and serving data of this type.

ACTIVITIES/ACCOMPLISHMENTS TO DATE

Our project officially begins February 1, 2001, so we have only commenced preparation for our project. All partners have been compiling our taxonomic resources. Steinberg has hired 2 technicians on the project (one full time, one part time) who will start in February. Madin's laboratory has been working on recognition software for the zooplankton silhouette analyses, and Craddock has started work on the micronekton collections.

ANTICIPATED RESULTS

- 1) A multiple species inventory covering diel, seasonal, interannual, and decadal time scales, as well as several depth strata, will allow proper coverage of zooplankton community structure, which is intensely dependent upon these variables.
- 2) New species will likely be discovered.
- 3) Data sets will capture important phenomena of scientific interest, such as intense 'blooms' of gelatinous zooplankton, or appearance of unusual species.
- 4) Use of the 10 year data set will be enable us to dissect the difference between natural variability and real 'change' in plankton communities.

PRODUCTS

- 1) Species lists with accompanying images will become available for use of the broader scientific and education community for many different applications.
- 2) Species abundance and size spectra made available for use in ecological modeling.

3) Species composition of zooplankton at the BATS location at monthly, seasonal and interannual time scales, and depth-stratified species occurrence of larger zooplankton and micronekton with seasonal and annual resolution.

BENEFITS

- 1) Tie in with larger environmental data set from BATS (among the highest quality oceanographic data sets in the world) will benefit the oceanographic research community.
- 2) Information on seasonal and interannual variability in zooplankton biomass and species composition is crucial for testing and validation of ecosystem models, and for understanding the effects of long term climate change on ecosystems.
- 3) Addresses other socioeconomic issues of importance such as improved prediction of variability and impact of fisheries
- 4) Long-term benefits as sampling will continue into the future
- 5) Information from data set will benefit both the research and educational communities by providing high quality, long term species composition data

TITLE: FishNet

E. O. Wiley, University of Kansas

Project Partners:

Co-Investigators: C. Richard Robins, David Vieglais, A. Townsend Peterson.

Technical Personnel: Joel Kolatch, Aimee Stewart (funded through an NSF grant, "Knowledge and Distributed Intelligence" (KDI) to Jim Beach, KU, that has overlapping interests).

Partner Institutions: Academy of Natural Sciences, Philadelphia, The American Museum of Natural History, The Australian Museum, The Bernice P. Bishop Museum, The California Academy of Sciences, The Canadian Museum of Nature, Cornell University Ichthyology Collection, Field Museum of Natural History, Florida Museum of Natural History, Gulf Coast Research Laboratory Museum, University of Southern Mississippi, Harvard University Museum of Comparative Zoology, JLB Smith Institute, Muséum National d'Histoire Naturelle, National Museum of Natural History, Smithsonian Institution, Natural History Museum of Los Angeles County, Royal Ontario Museum, Scripps Institution of Oceanography, Swedish Museum of Natural History, Texas Memorial Museum, Tulane University Natural History Museum, University of Alabama Ichthyology Collection, University of Kansas, and The University of Michigan Museum of Zoology.

Award Made: FY 2000

PROJECT OBJECTIVES

The major objective of the FishNet project is to provide an integrated and distributed network of marine biodiversity information that will be available to anyone over the world-wide web or through an appropriate client program operating on a personal computer. Partners include 23 major fish collections in the United States, Canada, Europe, South Africa, and Australia, with a combined total of over 36 million fish specimens.

FishNet will include an interactive search and query system, facilities for data download, and facilities for synthetic analysis of fish biodiversity data. FishNet will provide participating institutions (partners) with the technology and training needed to use FISHNET effectively and

expand the FISHNET network. Finally, we will demonstrate the use of distributed biodiversity information systems through applied research and education.

ACCOMPLISHMENTS TO DATE

1. Much of the initial four months of the grant period have been devoted to planning the expansion of the prototype system. This has included identification of key personnel needed to implement the system, identification of key personnel at partner institutions (i.e. the information technology staff), and identification of physical facilities at KU necessary to carry out the work.
2. Vieglais has continued development of the Species Analyst to improve its utility and streamline the user interface.
3. We have written job descriptions, advertised, and hired key personnel. This includes a database programmer (Joel Kolatch) specifically targeted for the Fishnet project and funded through our grant, and a colleague funded through other resources who will concentrate part of her time on FishNet in the GIS environment.
4. We have installed but not fully implemented a server at one partner institution (The Australian Museum) and provided the technical expertise to help a new partner (JLB Smith Institute of South Africa) to join the project. We have not made a mass order of other servers for our remaining partners, choosing to wait until the database programmer is on board and oriented to the tasks involved.
5. We have come to an agreement with FishBase as to mutual cooperation in reaching the overall goals of the Census of Marine Life. This will provide a positive and non-competitive environment that will enhance both initiatives.

ANTICIPATED RESULTS

1. We have begun the process of ordering and configuring servers. Kolatch will coordinate with partner institutions and program server software for Z39.50 client applications. We anticipate that at least half of all partner institutions will be on line by July, 2001. We hope to complete the basic installation of the network by early Fall, 2001.
2. We will initiate a self-reporting system as part of the network functionality. This will consist of daily checks of each server on the network and automatic reporting of any problems.
3. We will assist partner institutions in developing program scripts for automatic updating of master databases to the Z39.50 servers installed at their institutions.
4. As part of an agreement between FishNet and KDI, Stewart will work on two projects essential to the long-term functionality of the FishNet system. The first is automated geo-referencing to provide enhanced functionality to non-georeferenced collection records so that they can be used in a GIS environment. (A geo-referenced record is one that specified a latitude and longitude for a particular collection locality.) The second is the identification and compilation of electronic environmental coverages that can be used in concert with the specimen data to provide predictive biogeography/ecological niche capability using The Species Analyst (the client program that implements Z39.50 distributed database integration) and GARP (a generic algorithm program that provides integration of specimen and environmental data).
5. Kolatch will work closely with Stewart to provide solutions to integrate geo-reference information with the existing databases where this information is missing. This will provide "value added" for each individual partner's database.
6. Vieglais will continue to develop The Species Analyst to provide improvements for users.
7. Through partnership with KDI, programmers are now working on an improved version of GARP.

8. As the FishNet distributed network matures, the principle investigators will use the information available in the system in research projects designed to show the research value of the system relative to the goals of the Census of Marine Life.

E. OUTREACH/EDUCATION

TITLE: Descending the Ocean Ladder Robert D. Ballard, Institute for Exploration

Project Director: Stephen M. Coan, Ph.D.
The JASON Foundation for Education, 11 Second Avenue, Needham, Massachusetts 02494
Phone: 781-444-8858 x227 e-mail: steve@jason.org

Project Partners:
University of Wisconsin
University of North Carolina, Wilmington
National Oceanic and Atmospheric Administration, National Undersea Research Program
National Aeronautics and Space Administration
EDS
Sun Microsystems
Bermuda Biological Station for Research
JASON Foundation for Education
Massachusetts JASON
Institute for Exploration
Mote Marine Laboratory
National Geographic Society

Award Made: FY 1997; Renewed FY 2000

INTRODUCTION

The JASON Project has made significant progress in 2000 and 2001 in bringing the excitement of oceanographic research and exploration to millions of students and teachers throughout the United States. With NOPP support, JASON has solidified partnerships with key organizations, developed ongoing oceanographic programming, and pioneered the use of new and emerging technologies in bringing oceanography to students and teachers.

The following report presents each of the goals outlined in our April 2000 proposal to NOPP and the progress that we have made in reaching these goals. Also included in this report are an outline of the JASON Project and its components and a description of the JASON XII program.

Goal 1:

Support permanent interactive connectivity from the underwater research station Aquarius, including curricular context, web design, and activities to help students and teachers understand and learn from and about the engineering of the Aquarius, exploration and research in extreme environments, and deep ocean environments.

Report:

During the past year JASON has been working closely with the National Ocean Service, and the National Marine Sanctuaries Program to develop an ongoing educational program that will feature the Florida Bay National Marine Sanctuary and include broadcasts and other programming

originating from the Aquarius. Several planning sessions have taken place to determine how this program could become a permanent feature in educational settings, libraries, and after-school venues.

In January 2001 a team of experts from the National Marine Sanctuaries program, Media Arts, Inc., the JASON Foundation for Education, and other educational organizations met in Key Largo, Florida to develop an action plan for meeting this goal. The Key Largo meeting was the result of more than a year of discussions regarding the concept and feasibility of this kind of a program between key partners in this project including the University of Wisconsin-Milwaukee, Institute for Exploration, and NOAA.

During the JASON XII program for the 2000-2001 academic year students and teachers are engaged in activities related to ocean environments, particularly in Hawaii, as well as the tools used by humans to explore extreme environments.

Goal 2:

Transition materials and web cam equipment established with generous support from NOPP for the JASON Project VII expedition in 1997 to permanent resources for students and teachers. Virtual reality simulations and other methods are proposed to provide context for live web cams installed under the original grant as well as ongoing interactive opportunities in classrooms and at Primary Interactive Network Sites. During the initial grant period the web cams explored deep ocean environments and followed researchers on a particular expedition. This equipment can now be deployed on a permanent basis provided that appropriate context and content is created to maximize the learning value.

Report:

JASON has been working with Mote Marine Laboratories and the Bermuda Biological Research Station to implement content on the Web from the web cams at each of these locations. During 2000 grant support was provided to both institutions to support additional programming. This has included coverage of some research expeditions at each location as well the design of a long-term plan for continuing this effort.

Additionally, the JASON Foundation for Education has made significant improvements in student interactivity with research expeditions as specified in the grant. These improvements include the creation of various modules for Team JASON Online including chat sessions with researchers, tools for tracking data sets from ocean environments, modular activities relating to oceanography, and the capacity to follow mini-expeditions and events in oceanographic research around the world.

The interactive platform for the JASON XII program has been redesigned to provide greater interactive opportunities for Primary Interactive Network Sites. Improvements include new software and upgraded technical infrastructure to improve the speed and efficiency of student interaction with the JASON XII expedition.

Goal 3:

Build upon the capabilities and competencies established during the world's first Internet expedition to the East Pacific Rise in 1998. Plan and execute an educational initiative that will take students on an expedition to the Black Sea sponsored by the Institute for Exploration and Dr. Robert Ballard.

The expedition model will mirror the approach used on the East Pacific Rise cruise, allowing students and teachers access to researchers, data, and images via the Web, and providing curricular context.

Report:

During the 2000-2001 academic year the JASON Project is collaborating extensively with the Institute for Exploration, Earthwatch, and the University of Wisconsin-Milwaukee to develop several mini-expeditions focusing on oceanographic research and exploration.

Each of these mini-expeditions feature extensive interaction with the JASON web site and ongoing coverage of research, data, and findings from the expedition. In the fall of 1999 the JASON Project followed Dr. Robert Ballard's work in the Black Sea including posting images and data. With grant support from NOPP, JASON is also participating in an Earthwatch expedition to the National Marine Sanctuary in Hawaii to track the movement of Humpback whales.

Also, the JASON Project is working with the University of Wisconsin-Milwaukee and the Great Lakes Schooner program to follow the progress of inner-city Milwaukee students as they undertake an educational voyage aboard an 18th century schooner through the Stellwagen Bank National Marine Sanctuary and the Florida National Marine Sanctuary.

Each expedition is linked closely with JASON curricular materials distributed in printed format. During the 2000-2001 academic year, JASON launched an after-school curriculum entitled "JASON Beyond School" which is focusing exclusively on ocean environments and which uses mini-expeditions. Additionally, online activities available on the public Web site and the gated Internet site Team JASON Online are produced in concert with these mini-expeditions.

Goal 4:

Continue expanding JASON's reach to key states including Alaska, Kentucky, Mississippi, Massachusetts, Maryland, Texas, New York, Montana, California, South Carolina and Nebraska. Some NOPP funds will be used for continuation of this expansion, while the majority of funds for this purpose will come from other sources.

Report:

JASON has expanded its reach and presence dramatically during the past two years. With support from NOPP, the JASON Project is making programming available to all schools in the Commonwealth of Massachusetts during the 2000-2001 academic year through a partnership with Mass Interaction, the state telecommunications agency.

JASON's demographic profile mirrors the national student population. During the past year, through other grant support, significant progress has been made in reaching primarily minority schools in urban areas as well as students residing on Indian reservations.

JASON is distributed to teachers through a unit that includes the following components:

248 page curriculum

30 minute prologue video

Access to Team JASON Online

Team JASON Online Teachers Guide

TITLE: Enhancing K-12 Science Education Via Satellite-televised Interactive Technologies
Dr. Paula G. Coble, College of Marine Science, University of South Florida

140 Seventh Ave. S., St. Petersburg, FL 33701
(727)553-1631 voice, (727)553-1189FAX

Teresa Greely and Dr. Margaret Hewitt (co-Principal Investigators), College of Marine Science,
University of South Florida

Project Partners:

Dr. C. Pilskaln, Univ. Maine
Dr. Sharon Walker, COAST Program, Miss. State Univ.
Mr. Guy Nickerson, Spectrum Productions, Inc.
Pinellas County Board of Commissioners
Florida Marine Research Institution
U.S. Geological Survey, Marine and Coastal Program
Dr. Sylvia Earle, Sustainable Seas Expedition
Dr. William Hamner, UCLA, SSWIMS Program
Florida Institute of Oceanography
The Pier Aquarium
Pinellas County Schools

Project Web Address: <http://www.marine.usf.edu/pjocean>

Award Made: FY 1997; Renewed: FY 2000

LONG-TERM GOAL

To support of the goals of the NOPP Education, Outreach, and Training activities by providing a telepresence for science education and developing K-12 marine science curriculum and supplemental activities.

PROJECT GOALS AND OBJECTIVES

The immediate goals of this project are to expand and enhance the impact of Project Oceanography by increasing participation of scientists, teachers, students, and the community, and by improving production quality and format.

APPROACH

Project Oceanography, a televised program on a variety of Ocean Science topics, is designed to provide recent, relevant research results embedded with the required physics, chemistry, geology, biology, or mathematics needed by the student to fully comprehend the causes and implications of the real-world environmental problems. Presented by the actual research scientists, middle school science students and teachers are exposed to the wealth of knowledge, resources, and state-of-the-art facilities of the Ocean Science research community. Real-time interactivity is possible via two-way audio and video technologies, and programs can originate virtually anywhere on the planet.

ACTIVITIES

Project Oceanography is an academic year production, thus activities for Year I of this award reflect primarily those which occurred in conjunction with our Fall schedule. By increasing the cost per program, we have also been able to incorporate more location filming and pre-production activities. We redesigned our program format to include several program-branding elements, which students can expect to see in every program. These include a host biography at the beginning of each program and two review segments which summarize program content after 7 and 14 minutes of programming. These elements not only enhance the educational value of the program, but also makes the host scientist's job easier and more enjoyable.

We have also increased community participation in the production of Project Oceanography. The first three programs on Neighborhood Water Quality incorporated two days of filming during an inner city water reservoir clean up activity. Two programs in the second Fall series, Sounds of the Sea, were filmed in Cleveland, Ohio in the studios of WVIZ-TV before a live audience of inner city students from Cleveland with a live 2-way video link with 2 classrooms at a remote site. The Cleveland project was such a success that WVIZ-TV has decided to broadcast Project Oceanography live starting in Spring 2001, and has asked us to return to film additional programs in the future. We are also investigating the possibility of establishing additional program enhancements for the NE Ohio schools in Spring 2001.

Success of Project Oceanography is also measured by the increase in participating sites from 285 in 32 states and 2 foreign countries to 402 sites in 40 states and 8 foreign countries. This includes an increase from 64 to 72 ITV stations that reach an estimated 2 million 6th, 7th, and 8th grade students in 3,500 schools. Our program is now being used in several foreign countries, primarily by watching archived programs available on demand from our web site. In addition, UWTV in Seattle, WA is webcasting its rebroadcasts of Project Oceanography.

Teacher packets for Spring 2001 programs have been completed and preparations for broadcasts, including location filming is underway. Topics to be aired include: Antarctic Ecology, Fisheries Management, Red Tides and Harmful Algal Blooms, Water & Life, Microsystems Technology, Detecting Coastal Change with Lasers, and SSWIMS Program presents Squids.

The tentative program schedule for the 2001-2002 year has been prepared, with topics to include: Sustainable Seas Expedition: Channel Islands and Monterey Bay National Marine Sanctuaries (to be produced on location in CA), Hydrodynamics and Biophysics of Marine Organisms, three programs in collaboration with our COAST Program partners (Ocean Bathymetry, Coastal Hazards, 3-D visualization), Aquatic Insects, and Life Styles of Single (Celled) Organisms.

Additional funding for activities has been obtained from the Martha Holden Jennings Foundation, the Wean Foundation, Pinellas County Board of Commissioners, the Florida Marine Research Institute, and the Pinellas County Environmental Foundation. Additional partners in our past and future program activities include: WVIZ-TV (Cleveland, OH), KLCS-TV (Los Angeles, CA), Los Angeles Public Schools, Channel Islands National Park, Pinellas County Department of Environmental Management, University of California Santa Barbara Institute for Marine Science, Dr. Michelle Wood (University of Oregon), Dr. Florence Thomas (USF), SW Florida Water

Management District (Swiftmud), Center for Ocean Technology, Ocean Optics, MOSI (Museum of Science and Industry, Tampa FL), and Texas A & M University.

ANTICIPATED RESULTS AND IMPACT

In August 2000, fliers were mailed to all registered teacher participants offering them a free water test kit in return for filling out a survey concerning student demographics and evaluation of Project Oceanography products. A total of 42 replies were received from teachers, of which 17% were new to the program (no prior participation). Average duration of participation in Project Oceanography for all respondents was 1.5 years, and the average number of programs watched during the funding period was 13.5 (total of 102 programs have been broadcast since the inception of Project Oceanography in 1996). Respondents indicated the following demographics for the 4,653 students reported:

Ethnicity: 66% White, 16% African American, 8% Hispanic, 5% Asian American, 1% Other

School Setting: 50% urban, 26% suburban, 19% rural, 5% all (museums/aquaria)

Geographic Setting: 50% FL, 12% CA, 38% other U.S. Academic Program: 50% drop-out prevention or special needs programs, 17% home schools, 12% magnet programs, 21% other or unspecified.

Teachers responding to the survey were asked to rate the three major products of Project Oceanography relative to other materials available to them in their classrooms.

Ratings of products (on a scale of 1 to 5, with 5 being highest quality):

Written: 4.58

Video (or CD-ROMs): 4.24

Internet: 4.28

PUBLICATIONS AND PRESENTATIONS

1. Walker, S. H., *P.G. Coble*, and F.L. Larkin. 2000. Ocean Sciences Education for the 21st Century. *Oceanography* 13: 32-39.

2. Project Oceanography, 2000. Vol. IV, Numbers 1-9. College of Marine Science, USF, St. Petersburg, FL. 99p. Videotapes and written materials.

3. Exhibited programs materials at the National Marine Educators Association Annual Meeting in Long Beach, CA July 17-21, 2000.

Title: Bringing the Ocean to the K-12 Classroom Using a Coastal Ocean Observation Laboratory and a National Estuarine Research Reserve

Michael De Luca and Janice McDonnell, Institute of Marine & Coastal Sciences at Rutgers University

Project Partners:

Jacques Cousteau National Estuarine Research Reserve

Turnstone Publishing Inc.

Educator representatives from NJ middle and high schools including Harrington Middle School, Upper Township Middle School, Homdel High School, Medford Memorial School, Bernardsville High School, Ocean County Marine Academy of Science Technology Education (MATES), Mt. Laurel High School, and the United Nations School, NY, NY

Center for Advanced Information Processing (CAIP) Center, Rutgers University

National Undersea Research Program (NURP)
Tuckerton Seaport
Bell Atlantic

KEY PROGRAM OBJECTIVES

- 1) Bring technology and science to the pre-college classroom using innovative, activity-based classroom and Internet exercises.
- 2) Develop and publish lesson plans that would be used by educators inside the classroom where the real-time data and satellite imagery available at LEO-15 and other resources available at IMCS would be incorporated into their science curriculum.
- 3) Develop a series of distance learning programs, virtual field trips, and an on-line email network to support the implementation of the material in the classroom.

ACTIVITIES/ACCOMPLISHMENTS TO DATE

The project has made significant progress in achieving the project goals and objectives. In early August IMCS staff met with project partner, Dr. Deborah Silver of the CAIP Center to discuss the project's need for 3D animated graphics for the curriculum revision project. This meeting resulted in Wes Townshend, a computer graphics graduate student, being assigned to the project to develop a 3D visualization graphic of the LEO experiment. A draft of the model can be viewed at <http://www.caip.rutgers.edu/~wmt/imcs/>. This graphic will be used as a tool for students and educators to get a first hand understanding of the bathymetry, geography and biological character of the LEO experiment area. The model will take students on a visual tour of the range of equipment and technology involved in the experiment. This model is expected to be the central element to the revision of the introduction of the LEO/COOL experiment. Mr. Townsend is currently working on the final revision of the model (due to be completed in mid March 2001). The final version will be posted on the Internet site and will be used in a CD-ROM publication to be developed for the project.

In mid September, IMCS staff hosted a brainstorming meeting to discuss the status of technology in the classroom. Experts in marine education and classroom technology, including Dr. Sharon Walker- University of Mississippi, Dr. Paula Coble - University of Miami, Dr. Edward Friedman - Stevens Institute of Technology Center for Improved Engineering and Science Education (CIESE), Mr. Davis Bolt, Executive Producer PBS Series Digital Divide, Dr. David Smith – Project MAURY, and Susan Lovelace creator of the Estuaries Live -streaming video project from the North Carolina NERR were invited to consult on the LEO/COOL curriculum revision. They participated in a three-day review of our program and provided comment on how the LEO curriculum development project should proceed. At this meeting, IMCS staff was able to explore a potential working relationship with Turnstone Publishing Inc. As a small publishing firm that specializes in working with academic institutions to produce classroom materials, Turnstone provided a proposal to develop a concept document that would refine the curriculum development plan and would assess the market potential from publishers for the final product.

November 1999, IMCS staff met with curriculum and editorial staff from Turnstone Publishing to discuss the development of a concept document that would result in a nationally distributed hands-on (i.e. paper curriculum) and Internet modules. These two pieces would represent the current science and real-time data available from the LEO experiment and the Coastal Ocean Observation Laboratory (COOL). A concept document (available on request) outlining the objectives, barriers,

and proposed action was developed and discussed. This document was used to create a plan of action for the selection and assignment of curriculum development and revision tasks for IMCS staff and our public school educator partners.

In early January, IMCS staff met with the Dr. Edward Friedman who is the Director of the Center for Improved Engineering and Science Education (CIESE) at Stevens Institute of Technology. As a partner in the project, Dr. Friedman established contact with the United Nations School in NY, NY as a potential field-test site for the LEO hands-on and web based materials currently in development. Dr. Brian Kahn, who is the Dean of Science for the International Baccalaureate program offered through the United Nations, will be sending 3-4 of the IB school science staff to act as collaborators in the project. This adds an international dimension to the project and the potential to work with elite science teacher professionals on the development of the LEO/COOL modules. It is our goal that this IB school will work collaboratively with a sister school located in an inner city with special needs. This collaboration will ensure that LEO/COOL science will be translated at all appropriate levels.

ANTICIPATED RESULTS/IMPACT

With the support of the workgroup including Turnstone Publishing, we look forward to refining and publishing a minimum of 21 field-tested hands-on lessons to support the LEO on-line Internet program. Educators and their students will utilize real-time data generated from the LEO site to predict coastal upwelling and understand the physical oceanographic forces and the biological response in phytoplankton communities. Through the Jacques Cousteau NERR, educators and their students will use GIS tools to access sensitive habitats in the Barnegat Bay and Mullica River – Great Bay watersheds.

IMCS staff and partners will improve existing and develop additional Internet-based modules that focus on oceanographic data generated at LEO and within the Jacques Cousteau NERR. Our website will feature current research themes at LEO to develop compelling and creative lessons that take advantage of web-technology and help educators meet the National Core Curriculum Standards. With the support of Turnstone, we will develop and distribute LEO kits. The kits will consist of a CD-ROM that will introduce the science and technology of LEO, the paper curriculum of hands-on lesson plans, and a guide to the LEO website.

IMCS and partners will develop a prototype on-line field trip, a collaborative project, and a minimum of 6 distance learning classes to supplement the Internet and classroom materials. With the support of the Office of Continuous Education and Distance Learning at Rutgers, distance learning classes will be conducted to support the implementation of the LEO projects in middle and high schools.

TITLE: Bridge: Online Ocean Education Clearinghouse
Frances Lee Larkin and Vicki P. Clark, Virginia Institute of Marine Science

Project Partners:
Sea Grant,
National Marine Educators Association

Award Made FY: 1997; Renewed: FY 2000

The Bridge, a novel, web-based resource center and clearinghouse, brings together marine educators, academia, private industry, and government to provide educators with a comprehensive source of accurate and useful information on global, national, and regional marine science topics. The Bridge is unique among education portal sites in its focus on ocean sciences, its close ties to both the education and the research communities, and its facilitation of educators' use of online data. The Bridge project was initially funded in 1997, project activity began early in 1998 and the Bridge was officially launched August 1998 at the annual conference of the National Marine Educators Association (NMEA). The Bridge's primary target audience is high school and middle school science teachers. During the grant period, access logs recorded 1,630,665 hits, 265,315 page accesses and 142,954 visits. If visitation continues to increase at its present rate, hundreds of thousands of visitors will use the Bridge during the next several school years. An overview of project objectives and activities for the grant period of September 1997 to August 2000 follows.

Objective 1: Enable educators nationwide to access easily and efficiently a clearinghouse that conceptually organizes electronic resources for marine education in a comprehensive, pedagogically appropriate, and user-friendly manner. Online resources are of value to teachers only if they are able to use them. In the last few years, school access to the internet has increased to 95% (US DoEd, NCES) and teachers are becoming proficient in using the technology. The Bridge is easy to use and navigate. It functions as a quick-access directory, collecting and organizing links to selected websites. Customers are able to move through the Bridge to target information with only one or two clicks. Thirty-seven percent of visitors log into the Bridge more than once a month. The Argus Digital Librarian Clearinghouse awarded the Bridge their highest honors in December 1999, noting that it was not possible to get lost on the Bridge "even if you tried".

Objective 2: Enable the ocean sciences research community to reach teachers more efficiently with current informational products and data. Research-based information is a key element of the Bridge. Of the Bridge's approximately 900 links, 128 originate with authentic data from research facilities and 15 are to scientific journals. There is a special collection of sites containing data, and each month the Bridge staff produces a Data Tip that analyzes and interprets a topical collection of online data. Teachers evaluated the Data Tip feature in 2000 and 94% found Data Tips easy to understand. The Bridge staff is partnering with NOAA's National Marine Sanctuaries on a series of Data Tips, and several other collaborative efforts are in progress to facilitate delivery of research-based data and information to educators.

Objective 3: Improve educators' access to current data and marine information. The Bridge provides researchers with a central point for distribution of informational products and educators with access to these products through its pedagogically-friendly organization of links. Special links on the home page lead to featured sites and events such as Sustainable Seas Expeditions, National Ocean Sciences Bowls, Operation Pathfinder announcements and online teacher workshops. Including search engines, more than 1000 sites have linked to the bridge, according to Bridge access logs.

Objective 4: Provide educators with quality assurance that they need in order to be confident that the materials and information accessed are produced by credible sources and that they are consistent with the goals of supporting improved scientific literacy and systematic reform of science education. At the time the Bridge project was planned, the challenge was to locate websites of acceptable

quality from a field dominated by “brochureware” (webpages containing brief information promoting organizations), amateur hobbyists’ sites, and sites with agendas other than research and education. But this medium evolves rapidly, and the Bridge’s first year coincided with the launch of many research, science education, and government-sponsored websites featuring current, accurate information, and even some with enhancements for teachers and schoolchildren. Now, at the close of the Bridge’s second year, the number of good sites available and the overall quality of sites continue to rise. The task of selecting the best online materials has shifted from finding sites with accurate information and educational features to identifying the best from among a large field of informative, interesting, and useful sites. Two website review teams, TROLLS (Teacher Reviewers of On-Line Learning) and STARs (Scientific and Technical Advisory Reviewers), assist in evaluating sites.

Objective 5: Develop a broad-based, long-term partnership among National Ocean Partnership Program projects, NOAA/Sea Grant partners, NMEA and regional chapters, ocean sciences researchers, providers of oceanographic information, and educators. The complex partnering network developed with NMEA provides two-way communication with teachers and science education organizations nationwide. The NOPP grant projects were among the Bridge’s first featured sites, and the Bridge has continuously supported them through Data Tips and special announcements. The Bridge network extends throughout Sea Grant via web links and Sea Grant educators’ routine use and recommendations to others. Other partnering contributions have been made in the form of website links to the Bridge. Websites linked on the Bridge come from a variety of sources, including educational institutions, which provide 33% of all sites linked on the Bridge, non-profit organizations (24%), commercial sites (14%), and government organizations (11%).

Objective 6: Create a website and associated internet discussion group which will serve as a focal point for improved communications and exchange among educators and researchers. Scuttlebutt, the Bridge’s marine education e-mail discussion list, was launched late in 1998. Scuttlebutt is used by the NMEA Board and members, Sea Grant staff, classroom teachers, informal educators, members of NMEA regional Chapters, and others. During 2001, the Bridge staff will encourage scientists’ involvement by inviting researchers with expertise in the Data Tip topic areas to monitor the list for questions during the month that their topic is featured.

Objective 7: Provide sufficient information and professional development opportunities to inform educators nationwide about this resource and enable them to make effective use of the Bridge. Information about the Bridge has been disseminated to teachers nationally by a variety of methods and media. Announcements about the Bridge and invitations to link have been sent to science education webmasters. Staff and regional coordinators have conducted more than 83 training sessions for 5,629 educators. The Bridge is registered with major search engines and with smaller directory sites for educators, and meta tags on the Bridge main page, page titles, and file names invite search engines to locate the Bridge in response to searches for marine education resources. The staff has displayed an interactive Bridge exhibit at the national conferences of the National Science Teachers Association and the National Marine Educators Association every year since 1998.

Objective 8: Provide the research community with guidance in preparing web-based materials that are useful to teachers, and assurance that the materials that they prepare will reach a large audience of educators. Little of the web-based ocean science data on the web is in a form useful to K-12

educators. The Bridge maintains a reference page for researchers containing suggestions for developing web-based educational materials, information about education standards, links to information useful in working with K-12 audiences and teachers, and links to information about marine education projects in which researchers can become involved. The Bridge has also sponsored posters and presentations at scientific meetings and has sent announcements to newsletters of professional scientific societies and to their webmasters.

TITLE: Consortium for Oceanographic Activities for Students and Teachers: Putting Interactive Learning on Target (COAST: PILOT)
Sharon H. Walker, The University of Southern Mississippi

Primary Project Partners:

COAST:PILOT has involved 41 partners which include:

The J.L. Scott Marine Education Center and Aquarium and The University of Southern Mississippi;
The Center for Educational and Training Technology and the Electronic Visualization Lab in the School of Architecture at Mississippi State University;
The Teacher Education Department at St. Norbert College in De Pere, Wisconsin;
The U.S. Navy (Command, Naval Meteorology and Oceanography Command (CNMOC) and the Naval Oceanographic Office [NAVO]); and
The National Sea Grant College Program and its various state programs.

In addition, COAST:PILOT draws upon the strengths of numerous other partners. These COAST:PILOT partnerships include:

Six non profit institutions: The VA Institute of Marine Sciences, the J.L. Scott Marine Education Center and Aquarium, the Hatfield Marine Science Center, the National Marine Educators Association (NMEA), the National Geographic Society (NGS), and the National Science Teachers Association (NSTA);
Fourteen colleges and universities;
Twelve NOAA Sea College Programs,
The United States Geological Survey; and
Three industrial partners: Silicon Graphics; Palmer Johnson, Inc.; and Web Services, Inc.

Award Made: FY 1997; Renewed: FY 2000

PROJECT OBJECTIVES

- To foster an enhanced understanding of oceanography and coastal processes by COAST:PILOT–Pathfinder/Sea Scholars teachers;
- To continue research and developmental activities for K-12 precollege teachers;
- To include preservice teachers as participants, thereby preparing the next generation of classroom teachers with appropriate uses of technology and integrated curriculum;
- To strengthen curriculum impact through–partnering with specific schools and school districts through leadership teams; and
- To continue developing web-based resources that build on the curriculum and visualization resource structure established by COAST (1997-2000).

ACTIVITIES/ACCOMPLISHMENTS

- Twelve precollege teachers participated in a 14-day, three-hour credit COAST:PILOT–Pathfinder Institute, allowing participants to increase their content knowledge, augment instructional strategies, and enhance expertise in visualization technologies and computational science tools as related to oceanography and coastal processes;
- An average 106,000 page requests per month have been documented on the COAST Web site at <<http://www.nopp.coast.org/toc.html>> for the 2000 calendar year;
- COAST:PILOT Recruitment plans for 2001-2002 have been implemented;
- Two Sea Scholar voyages were made in the Spring and Fall of 2000 involving an additional 23 classroom teachers;
- Four articles have been published in professional and popular magazines;
- Presentations have been made at professional national and state organizations;
- NAVO personnel engaged in shipboard instruction for 27 Sea Scholars;
- COAST:PILOT URLs include Pathfinder at <www.aquarium.usm.edu/coast01.htm>;
- Sea Scholars at <<http://voyager.snc.edu>> and STARBOARD <www.coast-nopp.org/coast-partners/starbord/index.html>;
- Land-based studies between ports of call that explore the connection between geography and oceanography (Key West, FL; Corpus Christi, Texas; New Orleans, LA; and Jacksonville, FL ports) were successfully achieved;
- Evaluation and assessment revealed significant differences in pre- and posttest cognitive achievement scores by all participants and Likert-scale attitudinal achievement revealing that all participants perceived content, presenters, activities, and field trips between 82% to 97% Very Valuable and/or Valuable and between 3% to 18% Average and/or Limited Value;
- To date, six graduate students have been involved in this effort;
- Ten drifter buoys have been deployed as part of a complementary NOPP effort in the Caribbean (Puerto Rican Trench area and in the Dry Tortugas area of the Southern Gulf of Mexico) to monitor sea-surface temperature and currents; and
- Web site pages fostering oceanographic studies and instruction have been developed.

ANTICIPATED RESULTS/IMPACT

- Years 2 and 3 will involve 42 additional pre-and inservice teachers in two, 14-day COAST:PILOT Institutes (one in 2001 and one in 2002, each with 21 participants);
- In Years 2 and 3, up to 64 additional pre- and inservice teachers will be involved in Sea Scholars voyages in the Spring, Summer, and Fall with one Spring Sea Scholars voyage in 2002 with 16 participants per voyage;
- The 145 COAST Institutes (54) and Sea Scholars (91) will each impact an average of 20 “second tier” teachers in his/her staff development programs which include some content/activity aspect of the COAST:PILOT experience. These “second tier” participants are represented by an additional 2,900 teachers;
- These 3,045 (2,900+145) teachers—over a five-year teaching career—have the potential of positively impacting 1,674,750 precollege students relative to ocean sciences and technology from this country’s coastal and Great Lakes states;
- The continued use of the *Oceanographic and Coastal Processes Resource Guide* at <<http://www.nopp-coast.org/toc.html>> which is aligned with the *National Science Educational Standards*;

- Anticipated funding based on the success of this NOPP effort to encompass all fifty states, to include urban and rural teachers;
- Continued enhanced use of computational science and integrated curricula;
- Professional organizations such as NMEA, NSTA, and the NGS—by assisting the participating teachers—also contribute to the achievement of their respective missions; and
- A “win-win” relationship for all partners, i.e., sponsors, teacher participants, scientist/educator presenters, and precollege students who will help to shape the future for improved ocean science education on a national level.

This COAST:PILOT effort is about one thing, our nation being prepared for the opportunities and challenges in the 21st Century. This NOPP-funded project has leveraged investments in ocean sciences education content based on research results and the use of technology to promote national networking which has allowed delivery of these data to teachers and classrooms nationwide. In reviewing this ambitious project, it is obvious—as with most problems facing us today—there are no singular, simplistic solutions, only carefully considered, multiple approaches which will lead to incremental improvements for the next decade and beyond.